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A Martin-Tractor attached to the "water tower."

The Water Tower

A New Type of Horseless Fire-fighting Truck

We have had occasion repeatedly to draw attention to various adaptations of the automobile to fire service. There are a number of reasons why just for this function motor propulsion should be adopted in preference to the old-fashioned horse traction. As yet there has been no standardization in the form of motor vehicles for this branch of public service, and it is therefore interesting to take note of such original designs as are brought out from time to time.

A novel vehicle of this kind has just made its appearance on the streets of Springfield, Mass., which creates as much excitement as did the first horseless carriage some years ago. It consists of a piece of fire-fighting apparatus, known as a water tower, with a motor attachment in front, to take the place of horses.

The device is built on a steel frame carrying a motor and transmission machinery, which is placed in front of a fire engine or other apparatus originally designed to be horse drawn. It rests on the front axle of the vehicle to which it is attached. In front the structure is supported by a single wheel or two wheels placed close together. This arrangement gives it a more or less freaky appearance, but is said to be necessary in order to make short turns and handle the vehicle in narrow streets.

The frame is supported on easy springs both in front and in the rear, which prevents the engine and drawing mechanism from being shaken to pieces on rough roads. The engine is geared by means of chains and sprockets to the front wheels of the vehicle, the whole making a complete motor-drawn piece of fire-fighting apparatus.

This device is adapted to all kinds of heavy trucking as well as it is to fire apparatus.

Mr. Martin, the inventor, speaking of the machine, says: "It proved in practice all it promised in theory, and that is all we could ask. We are more than pleased with the tests. We carried 18,000 pounds up an 8 per cent grade on muddy road surface with only 21 per cent of the total load on the driving wheels, which were fitted with special traction tread steel tires. There was not the slightest slippage, nor could we make the wheels skid on the wet asphalt, proving conclusively that it is possible to obtain traction with a steel tire.

"We then drove over curbs, through plowed fields, through sand banks, maneuvered through the woods,

Making a complete turn in a thirty-foot street. Tower and Tractor measure 57 feet over all.

and did tricks which would be impossible with ordinary motor-truck construction. We described a complete half circle with the frame and the vehicle moved forward one foot, showing that we could drive through the differential and handle the vehicle just as we would with a pair of horses."

Every city in the country has several ladders, steam fire engines, and other horse-drawn apparatus of proven worth, which does not lend itself to ordinary automobile construction, that by the use of Martin's device can be adapted to motor driving.

It would appear that there might be a distinct field of usefulness for the new apparatus here figured and described, and if its merits upon further tests prove equal to the first impressions gained so far, and to the undoubted originality of the device, we may expect to find its scope of application to spread outside the limits of Springfield.

Principles of Water-Power Development—I.*

An Issue of the Greatest National Importance

By W. J. McGee

1. The development of water-power involves artificial regulation of streams. Proper regulation of running water for the several uses of water supply, irrigation, power and navigation can be effected only in the light of physical relations, the relations in equity and the more salient legal relations of water in streams.

PHYSICAL RELATIONS.

2. The fresh water of the land is derived directly from rainfall (including snow) and indirectly through evaporation from the sea. The mean annual rainfall on mainland United States ranges from less than 5 to over 100 inches, averaging 30 inches; the quantity aggregates about 5,000,000,000 acre-feet.[1] The distribution is unequal; over the eastward two-fifths of the country the mean is about 48 inches, over the median fifth some 30 inches, and over the westward two-fifths about 12 inches.[2]

3. In humid lands the water of rains and melting snows tends to gather into streams, generally taking the shortest and easiest paths to the sea, while in arid lands (except in a few rivers fed by the greater rain and snow of mountains) it tends to spread into dèbris-laden sheet-floods and will not flow down to the sea; lakes, in which water lodges for a time, are essentially expansions of streams due to what may be called geologic accidents, e. g., the Great Lakes chiefly to glacial scouring, the Millelacs to the irregular configuration of glacial-drift surfaces, Great Salt and Winnemucca lakes originally to warping of the earth crust; waterfalls, in which power is easily developed, are also due to geologic accidents, e. g., Niagara and Genesee and St. Anthony to conditions attending withdrawal of the Pleistocene glaciers, the cataracts of the Susquehanna and Potomac and James and the Dalles of the Columbia to displacement in the earth-crust.

4. In humid regions (including mountains in which rain and snow are more abundant than over neighboring lowlands) the streams carry a part only of the water reaching the surface, i. e., the run-off, averaging about one-third of the rainfall; about half the aggregate is evaporated, partly from the soil and open waters, though more freely from growing vegetation, forming a fly-off; while a smaller fraction (the cut-off) passes deeply into the earth to be absorbed in chemical combination or carried subterraneously to the sea. In arid regions there is (normally) no run-off and all the water except the small cut-off is evaporated to temper the local climate.

5. In a state of nature—and also under intensive cultivation—little if any storm water flows over the land surface apart from the streams; the rainfall is absorbed by the soil and its vegetal growth, and the streams are supplied partly by springs, but much more largely by seepage directly into their channels—this being the normal condition in which streams are generally clear and nearly uniform in flow.

6. Under certain conditions attending settlement, especially with injudicious clearing and negligent cultivation, a considerable part of the rain falling during storms runs off the land surface, erodes the soil, renders streams turbid, gathers into destructive floods and introduces wide fluctuations in flow (this representing what may be deemed a temporary condition in the history of the country, and one remediable by proper classification and use of the lands for purposes to which they are adapted, and by intensive cultivation of areas devoted to the growing of seasonal crops).

7. All parts of each stream are inter-related; increase or decrease in volume, inwash of detritus, the initiation of fluctuation or other changes in regimen at any point eventually affect the stream throughout; especially susceptible to disturbance at the sources are clarity and steadiness of flow at points whence water supply is commonly taken, in the middle course where power development is customary, and in the lower course devoted to navigation.

8. Normal streams, being derived chiefly from seepage, are maintained directly by the store of water accumulated in the ground as the residuum of rains of preceding seasons and decades, and only indirectly by the current rainfall. In the humid part of this country the ground water within the first hundred feet from the surface has been estimated at some 25 per cent of the volume of subsoil and rock, equivalent to 6 or 7 years' rainfall, i. e., it may be conceived as a reservoir of water 25 feet deep coinciding in area with the humid region. This reservoir is the chief source of the streams available for water-power and other purposes; it is also the reserve agricultural capital of the country, and the measure of productivity and habitability.

9. Under extensive clearing and cultivation, the store of ground water has been materially depleted. Recent determinations based on records (covering a mean period of about 22 years) of 9,507 wells in the nine States of Illinois, Indiana, Iowa, Kentucky, Michigan, Minnesota, Ohio, Tennessee and Wisconsin reveal lowering of the water-table at a minimum mean rate of 1.315 feet, or with moderate allowance for new wells 1.73 feet, per decade, corresponding to an aggregate of 13.8 feet for the 80 years since settlement began. This lowering of the level of saturation corresponds with an actual loss of water averaging 5.2 inches per decade, or nearly 150,000,000 acre-feet annually within the nine States. The loss is due largely to increased run-off in freshets and floods, which are in increasing degree wreaking destruction of property and loss of life; while innumerable springs and smaller source streams have disappeared, and the regimen of nearly all streams has been impaired.

10. The rate of subsidence of the water varies from State to State; it declines from 2.464 feet per decade in Minnesota to 0.8 foot in Ohio, while in Missouri it is but 0.43 foot. When the variable rates are coordinated with the geographic relations of the several States, it becomes clear that the ground-water reservoir of the entire interior is continuous, that Missouri is supplied in part by underflow from the Plains and Rocky Mountains, that the level in Ohio is kept up in part by seepage from Lake Erie (explaining that discrepancy between inflow and discharge from the lake which has led to excessive estimates of evaporation) and that Minnesota has merely lost proportionately with the absence of external sources of supply—in short that throughout this area of 532,402 square miles (and presumably elsewhere in the humid country) the reserve store of ground water is not only continuous and fairly conformable to the land surface but moves slowly down-slope in directions generally corresponding with those of the surface streams.

11. The recent researches demonstrate that the surface streams of the humid country available for water supply and navigation no less than power are interrelated through the ground-water reservoir in such wise that the regimen of each is dependent on the integrity of the ground reserve by which it is chiefly maintained. The essence of a stream resides in its continuity of flow; and this continuity of flow is in nature due absolutely and wholly to continuous supply from the store of ground-water.

12. Since the water vapor which bathes the continent and tempers its climate is not all precipitated on the land over which it passes, but in part goes on over adjacent seas; since the part precipitated as rain and snow and distilled as dew is largely re-evaporated from soil and open water, especially from growing plants whose vitality it sustains; since the residuum mainly soaks into the earth (and should do so wholly, in order to retain the best natural and artificial balance) where it forms a reserve store of ground water for a period averaging perhaps ten years; and since streams are fed chiefly—under the best conditions wholly—from this ground-water reserve, it follows that the fresh water of the country, as a whole, in its forms of vapor, rain, snow, dew, ground-water, lake and stream, is essentially a grand physical unit made up of interdependent parts, and that each stream, despite its essential unity and the interrelation of all its parts, is but an integer within the larger unit.

RELATIONS IN EQUITY.

13. Water is the prime necessary of life. Fully five-sixths of human food, and indeed, a like proportion of the human body, consists of H^2O or water, chiefly in its simple form, partly in chemical combinations. In the human organism water is essential to assimilation, to metabolism or structural growth, to reproduction—indeed it would appear that no vital process occurs in the absence of water or otherwise than as a manifestation of its inherent properties. In the plants and lower animals yielding human food and clothing, water plays an equally essential rôle—indeed without water the continent would be unproductive and uninhabitable, and the lands of the planet but a dead world.

14. In this as in other countries, water is the primary natural resource. Industrial and other forms of activity on which rest the power and growth of peoples and States depend absolutely on the maintenance of human life and population, which in turn depend on food and measurably on apparel; and whatever its breadth in land and wealth in minerals, no continent can sustain human life and population without sufficient water for drink and for producing from the soil the materials for solid food and clothing. The average crop plant transpires 450 times the weight of its own (dry) substance in water during its growth; and reckoning evaporation from the soil of the moisture required to maintain proper texture, the agricultural duty of water is to produce one-thousandth of its weight in average plant crop, or one four-thousandth in grain, or perhaps one forty-thousandth in meat.[3] Under rigid economy an adult human worker may be sustained for a year by 200 pounds each of bread and meat, with 2,000 pounds of water for drink; or, since the bread and meat require for their production respectively 400 tons and 4,000 tons of water, something over 4,400 tons of water in direct sustentation, apart from that required for ablution and for melioration of climate through aqueous vapor in the air. Under irrigation, where alone agricultural water is measured, a five-acre farm supplied with 60 inches of water per year will sustain a family of five, including surplus produce for exchange; this is at the rate of five acre-feet (about 6,800 tons) per inhabitant—at which rate mainland United States might sustain permanently, with its 5,000,000,000 acre-feet of rainfall, a population of 1,000,000,000; the 2,000,000,000 acres of land would indeed support over 2,000,000,000 people if occupied to the density of Belgium (649 per square mile), but neither land nor any other resource except water affords any measure whatever of the capacity of the country for production, population, power, or perpetuity.[4]

15. As the primary resource, water alone gives value not only to land (as is clearly realized in arid regions) but to all other resources. It is the ultimate basis of values, and can not equitably be regarded as an appurtenance to land or to any other subordinate resource, though in equity land and other resources may be—and in arid countries are commonly—considered practically appurtenant to the natural water.

16. As the prime necessary of life—the ultimate basis of existence for each of the individuals united in the nation—the water of the country is, under that leading principle of our national existence that all men are equally entitled to life, liberty and the pursuit of happiness, the common and indivisible possession of all—a possession in equity inalienable and indefeasible, since no constituent of the nation could alienate or divest himself of his share without surrendering his right to life and so weakening the nation.

17. As the common property and equitable possession of all, water in any form, together with the appurtenant lands or other resources, may be administered in the public interest by municipalities, States and the national government; but no public agency may in equity alienate, or divest the people of any part of the common interest in the water, nor may it equitably transfer any right to use of the water without just consideration in the public behalf. As the prime necessary of life and the primary resource, and as the common possession of all, water is in itself a special property, and its equitable administration is rightly the most

*Presented at a hearing of the National Waterways Commission, November 21, 1911, and published in *Science*.

[1] The acre-foot is a convenient unit not only because in common use throughout arid America, but because large enough to measure water in its national aspect without use of incomprehensibly large figures. It equals 43,560 cubic feet, 326,047 gallons, or 1,359.6 tons; it is something over a kilostere (equaling 1.2335 ks.), or cube of 10 meters.

[2] "Soil Erosion," Bureau of Soils Bulletin 71, 1911, p. 17.

[3] "The Agricultural Duty of Water," U. S. Department of Agriculture Yearbook for 1910, pp. 169–176.

[4] "Prospective Population of the United States," *Science*, vol. 34, 1911, pp. 428–435.

sacred trust confided by the people in their chosen representatives and officers.

18. While the uses of water are diverse, they are not equally essential to life and to that general development of the country on which its power and perpetuity must rest. Since life can exist without it for but a few days, the primary use of water is for drink and other domestic supply, in which it is consumed; since continuous life can be sustained and the generations maintained only through food and clothing produced by its consumption, the secondary use is for agriculture, including irrigation; since the measure of industrial proficiency is the conquest and use of power, the next use of water in order of importance is for mechanical power, in which its substance (or corpus) is not consumed though its movement is utilized; and since the activities of commerce are necessarily subordinate to the primary industries, the least essential use of water is for navigation, in which it is not consumed and only its inert corpus is utilized. Yet the several uses may and should be combined, as when water for domestic supply or irrigation is used for power—and the development of power generally promotes navigation.

19. Since individuals are merged in various business and civic organizations without loss or impairment of their individuality or their rights and duties as constituents of the nation; since the circulation of rain-yielding vapor is wholly independent of civil boundaries, while the movement of ground-water generally, and the courses of streams largely, are independent of such bounds; since water in artificial conduits and hydro-electric power are essentially commodities and the physical means of carrying them are frequently interstate; and since the chief uses of streams commonly vary in different parts of their courses and often in civil divisions, while the federal government alone can deal with interstate navigation and international waters, no municipality or State or federal agency can claim exclusive jurisdiction over water, or the exclusive right to administer it.

20. Since the chief purpose of statutes and common-law and courts is to prevent inequity, so that their nature is static and their effects generally prohibitive or restrictive or at most permissive, while the activity on which development depends is dynamic and constructive and in its essence progressive (wherefore it is not initiated but merely guided in direction by the static qualities of law and court) it follows that the inherently progressive development in the use of water attending the natural growth and orderly development of the people can best be fostered by combining individual and institutional agency in the highest practicable degree, i. e., by effective co-operation among individuals and both business and civic organizations, including corporations, communities, municipalities, States and federal agencies.

(To be Continued.)

Recent Improvements in the Aeroplane

By I. Ludlow

The most extraordinary of all points of improvement during the past nine months has been the universal adoption of the nearly flat surfaces. The usual wings on the Blériot monoplane of 1911 type have as little camber as a racing wing of the previous year; and the wings of Blériot's Gordon-Bennett racer are so flat that their curvature on the under side is barely perceptible to the eye. The experience of Blériot as a constructor is typical of all. The value of the deeply curved surfaces comes into play only when an aeroplane which has small surfaces is vol-planing in a more or less pancake fashion; then a greater resistance is offered by the deeply curved wings, and the aeroplane alights dropping at a slower speed.

The old theory that the deep curvature was essential to the aeroplane was discarded as powerful motors came into use. The blunt nose has also been tried and rejected. There is now a tendency to add a reverse curvature to the rear portion of the wings in order to obtain the stream line effect. The same principle is utilized when the hull of a boat is rounded rather than square at the stern.

No assertion that a deep curve at the front edge gives more efficient pressure on the under side of the wing, or that the curve is desirable in order to create a vacuum above for lifting purposes; and no statement that a curved surface causes a small movement of the center of pressure is now met with. These views have been proved fallacies, and the common sense doctrine remains, that the camber of the plane should be such that all portions of its surface are acted upon directly and uniformly, taking into account the deflection from the horizontal of some of the air particles through mutual interference.

The next remarkable development has been the placing of the center of thrust of the propeller in line with the leading edge of the wings. The Nieuport, Deperdussin, and R. E. P. monoplanes have all adopted this construction. In the Morane monoplane the center of thrust of the propeller is much nearer the line of the front edge of the wing than is the case with the Blériot model of which it is otherwise a close copy, except as regard the chassis and the cross-section of the fuselage, which has been reduced in size. It is probable that placing the hub of the propeller in line with the leading edge of the wings gives increased speed, as obviously a less proportion of air is thrown against the wings and fuselage. It is probable that this change also increases the natural stability of the monoplane, notwithstanding the fact that it raises the center of gravity. A high center of gravity has proved desirable in making turns. On the average aeroplane the angle of incidence on the inner side is increased after the machine is once banked when making a turn, in order to prevent that side from falling still further. The high center of gravity will lessen this tendency of the inner wing to drop in making the turn. No center of gravity, however, should be higher than the central longitudinal axis of the aeroplane.

Increased speed created by increased pull of the propeller will cause the angle of incidence of the monoplane to become larger where the center of pull is below the leading edge of the wings; and the increase or diminution of the pull will cause the monoplane to rise or fall and to act very much in the same manner as will a boy's kite in an unsteady breeze. If the center of the pull is on a line with the leading edge of the wings, the tendency is rather for the supporting surfaces to decrease or increase their angle of incidence with the increase or decrease of the power of the motor. The best possible construction would place the hub of the propeller, the center of gravity, and the central longitudinal axis of the monoplane all on the same line, and preserve lateral equilibrium by a small dihedral angle of the supporting surfaces, if a slight automatic stability is desired.

In the Morane monoplane, the fastest cross country monoplane of a European design, the wings are curved backward laterally on the front edge. The particular value of this form, is that it resists a turning movement on the vertical axis of the aeroplane. This result has its own inherent advantages.

The rear tail has become flat and non-lifting. This has required a perfect balance of the main supporting surfaces. The tail has now acquired the function of the feathers of an arrow, viz., to give a fixed direction to the line of flight. The fault of the small rear supporting surface with its angle of incidence lay in the fact that with increased speed the tail had a tendency to rise in a very lively manner and to threaten to upset the longitudinal equilibrium. Blériot placed a reverse curvature on the horizontal rudder of his seventy horse-power monoplane; but it is obvious that in thus curing the defect, the monoplane's head resistance was increased. At slow speeds the rear horizontal supporting surface failed to create its due proportion of uplift; and it became necessary for the aviator of a monoplane immediately on the stopping of the motor, to point the nose of the monoplane downward and begin his volplane.

The minimum area which the rear vertical rudder can be made has been found to be about nine square feet. In most cases it should be at least twelve square feet. In making a turn the inner wing of the aeroplane is depressed and there is a definite tendency for the depressed side to drop still further, and for the aeroplane to take a course which becomes increasingly spiral until it finally overturns. Warping the wings, or using the ailerons, will not restore the balance unless the depressed wing can be speeded up by changing the direction of flight. Under these conditions a rear vertical rudder of adequate size is essential for safety. Many an aeroplane has been wrecked in flight because of its failure in this particular. The above statement is a very different one from the claim of the Wrights, that the use of the side control creates a turning movement which must be corrected by use of the rear vertical rudder turned toward the side having the least angle of incidence.

Breguet discovered that placing two small vertical surfaces about eighteen inches square in his biplane directly under the upper surface, one each, at the next to the outer upright from either end gave good results in holding a straight course, in preventing a sliding movement toward the depressed side when making a turn, and in affording a good fulcrum against which the leverage of the rear vertical rudder might work. Alec Ogilvie used a like device in his Wright biplane in the Gordon-Bennett contest; Grahame-White has adopted this improvement on several of his biplanes, and Curtiss makes use of two diamond-shaped vertical surfaces in his front control.

Rules Governing the Competition for the $15,000 Flying Machine Prize Offered by Mr. Edwin Gould

1. A prize of $15,000 has been offered by Mr. Edwin Gould for the most perfect and practicable heavier-than-air flying machine, designed and demonstrated in this country, and equipped with two or more complete power plants (separate motors and propellers), so connected that any power plant may be operated independently, or that they may be used together.

CONDITIONS OF ENTRY.

2. Competitors for the prize must file with the Contest Committee complete drawings and specifications of their machines, in which the arrangement of the engines and propellers is clearly shown, with the mechanism for throwing into or out of gear one or all of the engines and propellers. Such entry should be addressed to the Contest Committee of the Gould-Scientific American Prize, 361 Broadway, New York city. Each contestant, in formally entering his machine, must specify its type (monoplane, biplane, helicopter, etc.), give its principal dimensions, the number and sizes of its motors and propellers, its horse-power fuel-carrying capacity, and the nature of its steering and controlling devices.

3. Entries must be received at the office of the Scientific American on or before June 1st, 1912. Contests will take place July 4th, 1912, and following days. At least two machines must be entered in the contest or the prize will not be awarded.

CONTEST COMMITTEE.

4. The committee will consist of a representative of the Scientific American, a representative of the Aero Club of America, and the representative of some technical institute. This committee shall pass upon the practicability and efficiency of all the machines entered in competition, and they shall also act as judges in determining which machine has made the best flights and complied with the tests upon which the winning of the prize is conditional. The decision of this committee shall be final.

CONDITIONS OF THE TEST.

5. Before making a flight each contestant or his agent must prove to the satisfaction of the Contest Committee that he is able to drive each engine and propeller independently of the other or others, and that he is able to couple up all engines and propellers and drive them in unison. No machine will be allowed to compete unless it can fulfill these requirements to the satisfaction of the Contest Committee. The prize shall not be awarded unless the competitor can demonstrate that he is able to drive his machine in a continuous flight, over a designated course; and for a period of at least one hour he must run with one of his power plants disconnected; also he must drive his engines during said flight alternately and together. Recording tachometers attached to the motors can probably be used to prove such performance.

In the judging of the performances of the various machines, the questions of stability, ease of control and safety will also be taken into consideration by the judges. The machine best fulfilling these conditions shall be awarded the prize.

6. All heavier-than-air machines of any type whatever—aeroplanes, helicopters, ornithopters, etc.—shall be entitled to compete for the prize, but all machines carrying a balloon or gas-containing envelope for purposes of support are excluded from the competition.

7. The flights will be made under reasonable conditions of weather. The judges will, at their discretion, order the flights to begin at any time they may see fit, provided they consider the weather conditions sufficiently favorable.

8. No entry fee will be charged, but the contestant must pay for the transportation of his machine to and from the field of trial.

9. The place of holding the trial shall be determined by the Contest Committee, and the location of such place of trial shall be announced on or about June 1st, 1912.

10. Mr. Edwin Gould, Munn & Co., Inc., publishers of the Scientific American, and the judges who will be selected to pass upon machines, are not to be held responsible for any accident which may occur in storing or demonstrating the machines on the testing ground.

Transparent Anatomical Preparations

Seeing Through Bone Without X-Rays

By Dr. Alfred Gradenwitz

ANATOMY has rightly been considered the basis of modern medicine. In order successfully to wage war with disease, the normal structure of the human body as well as any lesion produced by disease must be known in detail.

Now what are the methods at the disposal of the anatomist for obtaining an insight into the structure of our body? Dissection obviously allows each organ to be examined in its gross appearance, and every part of an organ and system of vessels or nerves can thus be somewhat laboriously isolated. X-ray observation on the other hand has lately afforded a means of studying the inside structure of the human body on living subjects without the use of the knife. But X-rays have their limitations, as the object can be viewed only from certain restricted points.

What a progress it would mean to anatomy if dissected organs and whole animal bodies could be made transparent, revealing all details of their structure and the paths of the vessels and nerves! This is what has actually been done by a German physician. His process is based on the following physical principle:

If an object be struck by light, part of the latter will penetrate into the interior while the remainder is thrown back or reflected from the surface. Any light penetrating into the object is either absorbed therein when the object appears opaque, or else freely passes through the object, which then appears transparent. As a matter of fact, there is no such thing as either absolute opaqueness nor absolute transparency, opaque bodies allowing some light to pass through very thin layers, while even in the most transparent bodies some minute portion of light is absorbed.

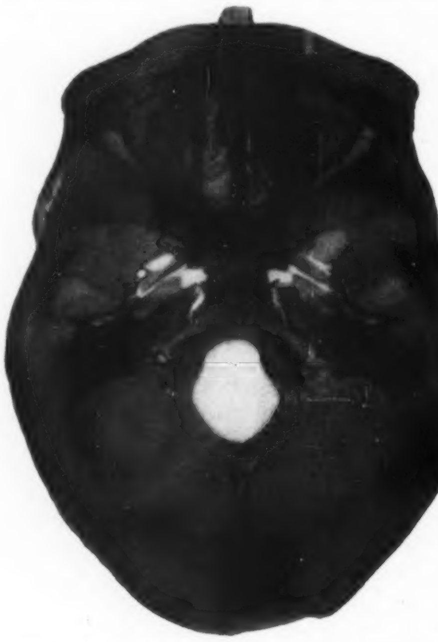
Now the amount of light thrown back from the body and accordingly the ratio between the light reflected and that penetrating mainly depends on the condition of the surface and on the kind of substances traversed by the light. If the surface be smooth it reflects less light than a rough, irregular surface (regular and diffuse reflections); in the former case a greater portion of light will penetrate into the interior of the body (e.g. in a polished glass plate) than in the latter case (e.g. a ground glass plate).

Any light penetrating into a given body is generally deflected from its original direction (refracted) at the boundary surface. As light passes from one substance into another, the amount of light penetrating into the second substance and the amount reflected from its surface also depends on the ratio of their refractive indexes. The more these two indexes differ, the less light enters the second substance and the more is thrown back from the boundary surface. On the other hand, the amount of light reflected reaches a minimum and the light penetrating into the body a maximum when the indexes of refraction of the two substances are equal to one another. This accordingly corresponds to the maximum transparency. This is why a ground glass plate becomes more transparent if coated with grease and perfectly transparent if immersed in a liquid of the same index of refraction as glass.

While these simple laws have long been applied in the case of inorganic substances in determining their index of refraction, it had never seemed possible to utilize them in connection with organic (animal or vegetable) bodies, where conditions are considerably more complicated. In fact, such bodies even in their simplest forms consist of different tissues made up in their turn of an infinity of microscopically small elements of varying refractive index. This is why not only the surface of the body itself, but that of each individual element reflects some light, so that the amount of light actually traversing the body is practically nil.

Now Prof. W. Spalteholz has shown that various organic preparations can be made transparent by impregnating them with a suitable material whose refractive index corresponds to the average index of the various structural elements of which the body to be treated is composed. If an organ be soaked in and surrounded with a liquid possessing this average index of refraction, the maximum transparency will be obtained. However, in the body thus made transparent any components with an index differing from the average will come out with different distinctness, the more distinctly as the difference of indexes is more considerable; moreover these components are the more visible as they show more striking color differences. A body thus made transparent therefore allows very fine details to be distinguished, in fact, frequently more minute details than are disclosed by X-ray observation, while the process obviously has the advantage of affording in the place of a picture the anatomical preparation itself, which can be inspected from all sides.

Prof. Spalteholz has found volatile oils and replated substances to be most suitable for the purpose on account of their comparative stability and chemical inertness. Of all the substances in question, only a very limited number, however, could be actually used



Human Skull Made Transparent by Impregnation With Organic Liquids.

Transparent Preparation of an Entire Frog.

and after extensive tests two liquids were eventually chosen, viz., the methyl ether of salicylic acid, the index of refraction of which is intermediate between 1.534 and 1.538, and benzyl benzoate, with an index intermediary between 1.568 and 1.570. By mixing these two liquids in variable proportions, all human (or animal) anatomical preparations can be made transparent. In order to make the outside surface of the liquid surrounding the body as regular as possible, it is inserted in a polished rectangular glass trough. A body thus treated allows the position of the bones, brains, heart, etc., to be readily distinguished, while by varying the index of refraction any tissue or organ desired can be brought out and others more or less effaced. It seems that the index of refraction of a given tissue is in some way or other related to the age of the animal, the index being the lower in younger animals. Most beautiful and instructive anatomical preparations are obtained by injecting the blood vessels with dyestuffs or by coloring the lime salts of the bones. Prof. Spalteholz is at present engaged in working out some satisfactory method of coloring the nerves in intact anatomical preparations which will doubtless lead to a remarkable extension of our knowledge of the nerve system.

The same process can obviously be utilized in connection with vegetable tissues, allowing, e.g. wood in thin layers to be made quite transparent; the structure of the wood then comes out with remarkable clearness.

Seaweed Harvest in Japan

In no other country in the world perhaps, are seaweeds utilized to the same extent as in Japan. At all seasons of the year this product of the deep is harvested. It forms not only a large item in the food of the people, but furnishes the raw material from which many articles of commerce are manufactured.

Of the more than 600 varieties of Japanese seaweed, there are few that have not some special use or value. Some are eaten with raw fish, others are dried and used as a relish. Certain varieties are used for the manufacture of glue, isinglass, iodine; some form a cheap and valuable fertilizer and others again are used on ceremonial occasions. Seaweed represents an annual income to the nation of no less than 3,000,000 yen ($1,500,000). *Amanori*, the most valuable and most common of Japanese seaweeds, is to be found everywhere along the coast of the Empire. Much of this is consumed as food, but the bulk is marketed in the dried state. The mode of securing the weed is as interesting as it is unique. The branches of trees are bunched together and made fast in bays and river mouths, where the daily tides bring in their harvest of the deep, and leave it clinging to the branches. Some time after the *amanori* has attached itself to its secure anchorage, it attains a growth sufficient to warrant collecting, which is usually done in November. The weed is at once washed in several changes of water, and after the sand and all foreign matters are eliminated the clean seaweed is placed on a chopping board where it is minced. It is then placed in a wooden receptacle, where water is allowed to drop on it through a bamboo screen. Finally it is dried in the sun, after which it is ready for the market, where it brings an annual return of nearly 2,000,000 yen ($1,000,000). The industry of dried nori has been carried on in Tokio for more than 100 years. *Kombu*, a different species, has to be steeped in water, and flavored with sugar and soy, before eating. It is mostly exported to China, packed in paper bags, where it finds consumption to the extent of nearly 1,000,000 yen a year. *Tengusa*, another species, is gathered by diving, this work being performed chiefly by women. That gathered in the warm season has a greater commercial value, as it contains a greater percentage of gelatine, its chief use being for the preparation of isinglass. It is dried, packed in straw bags, and sold to the manufacturers of isinglass and glue, the annual output having a value of about 400,000 yen ($200,000). A favorite Japanese sweetmeat, called yokan, is nothing more than isinglass, mixed with sugar, and prepared from the weed. The variety of seaweed known as *funori* is also used in the manufacture of glue and the demand for it has so increased of late that it now has to be imported from Korea. It is gathered at low tide, dried in the sun, sifted through bamboo screens, when it is ready to be made into glue, or else put through a refining process of repeated washings and sun drying, the chief use of the more refined product being the treatment to certain textiles to impart luster to them. —*Japan Magazine.*

A Tuning Fork of Invariable Pitch.—In a note published in *La Nature*, we read that Mr. Robin has succeeded in manufacturing, by means of a special steel, tuning forks whose pitch is not affected by temperature. This is one more new application added to the long list to which special steels have been put in recent years.

A Direct-Reading Torsional Dynamometer

A Power Meter Possessing Marked Advantages

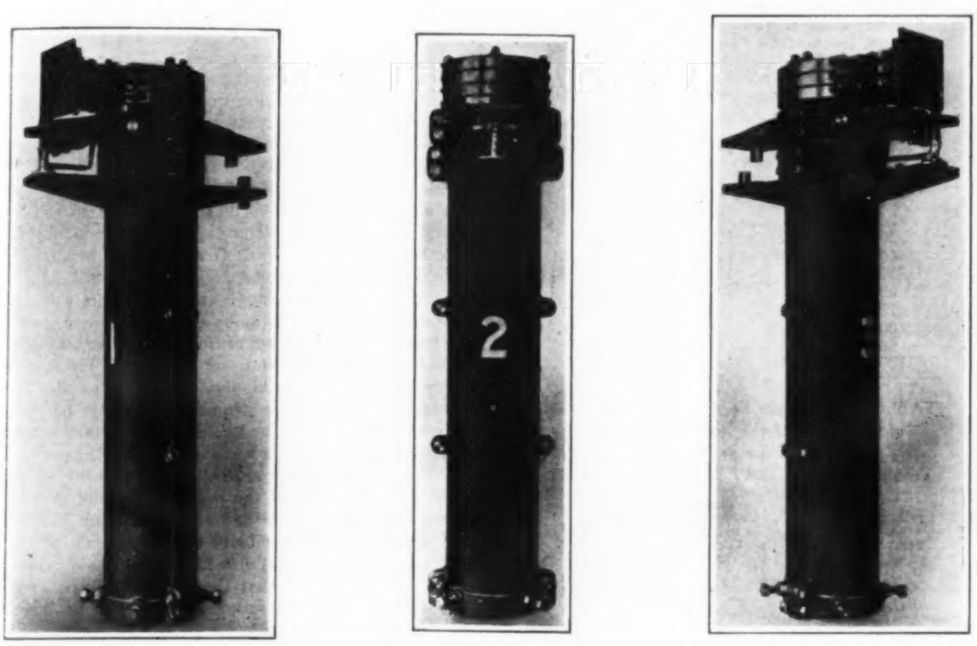


Fig. 1.—View of Shaft With Split Sleeve Attached.

When a rotating shaft is transmitting power, it is in a state of torsional strain, the magnitude of which stands in direct relation to the torque or turning moment exerted by the shaft. If then the torsion of the shaft and its speed of revolution are known, the rate at which it transmits power is readily deduced. This is the principle of various forms of torsional dynamometers which have been designed from time to time. A new type, which appears to possess some special advantages is shown in our illustrations.

Of these Figs. 1 and 3 shows a split-metal sleeve arranged on the shaft, the torsion of which it is desired to measure, one end of the sleeve being fixed to the shaft by means of pinching-screws.

The drawing Fig. 4 and illustration Fig. 2 show dials and the electrical connections of the direct-reading torsion-meter. The arm and sleeve rotate about a collar on a metal resting-piece, which is also provided with projecting arms similar to those on the sleeve, and fixed to the shaft by means of pinching-screws.

When the shaft twists, under the torque of the power transmitted, the arms on the sleeve and resting-piece respectively, are circumferentially displaced relatively to one another, so that the movement is a measure of the torsion of the length of shafting situated between the pinching screws. In order to measure accurately this movement of the arms, on one arm of the resting-piece is fixed a short strip of very high resistance material—a platinum-iridium alloy of extreme hardness and quite non-corrosive. Two slip-rings are connected to the ends of the resistance strip, so that a current of electricity may be passed along it, the current being led to and from the slip-rings by means of brushes and cables.

There is a small storage battery supplying the necessary current, and included, in circuit with the battery and each shunt, is a regulator by means of which the current flowing through the shunt may be adjusted at will.

On an arm of the sleeve is fixed a bracket carrying a spring contact-piece, which bears on the shunt, and makes contact with it. The contact-maker is also connected to a slip-ring, and thence to a brush, and by means of a suitable conductor to a torque-meter, which is practically a voltmeter, measuring the potential along the shunt when current is passed along it.

As the contact-maker moves along the shunt in one direction or the other, according as the vessel is going ahead or astern, the contact-maker, and hence the torque-meter, will be subjected to a higher or lower potential, and the instrument will read directly in proportion to this rise or fall, and therefore to the distance traveled by the contact; and this in turn is a measure of the torsion.

The torque-meter is calibrated in units of shunt-length instead of potential, and the full scale-length represents the total length of the shunt. The position of the contact when the shaft is transmitting no power is exactly at the middle of the shunt, and the pointer of the torque-meter consequently also at the center of its scale. This center point is made the zero of the torque-meter, and the pointer rises or falls from this point as previously explained, according to the direction of travel of the contact-maker on the shunt. The torque-meter scales are divided into tenths, one hundredths, and one-thousandths of an inch, and, the smallest divisions can easily be subdivided by the eye into two or more parts. As it is somewhat difficult to set the contact-maker exactly to the middle point of the shunt, and consequently the pointer of the torque-meter also exactly to zero, the scales of the torque-meter are made movable so that the zero point of the scale can be adjusted to correspond exactly with the position of the pointer. Thus the setting of the zero is a very simple operation.

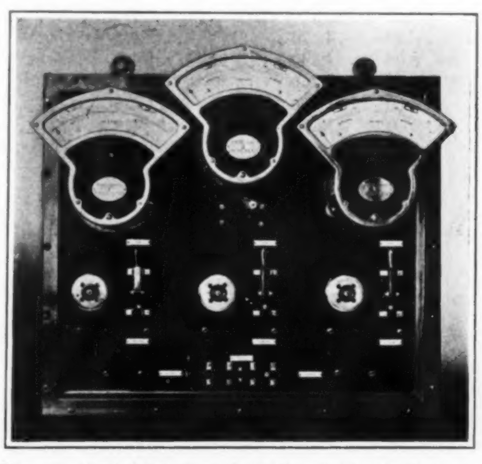


Fig. 2.—Switchboard and Dial of Torsional Dynamometer.

In taking a reading of torsion a two-way switch is put in the "test" position, this connects the torque-meter directly across the ends of the shunt. The regulator is then adjusted until the pointer of the meter comes to the extreme end of its scale. It is then definitely known that the necessary strength of current is flowing in the shunt to give a difference of potential between its ends corresponding to the full scale length of the torque-meter.

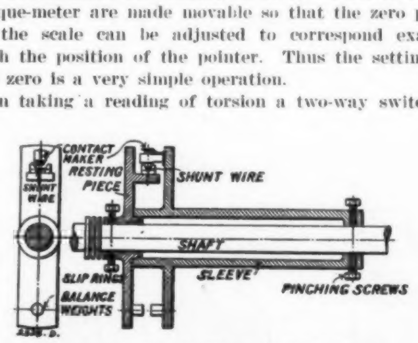


Fig. 3.—Sectional View of Split Sleeve.

This switch is then placed in the "reading" position connecting the torque-meter between the contact-maker and one end of the shunt, and the torsion is read off. The torque-meter can also be connected between the contact-maker and the other end of the shunt. The two readings thus obtained should be exactly equal, and this provides a simple and very definite check on the accuracy of the readings obtained. The two-way switch enables the torque-meter to be instantly checked with its shunt, and it is not necessary to ascertain what the voltage of the battery may be, nor what the strength of the current flowing in the shunt is.

The contact-maker could, of course, be "earthed" to the sleeve, i. e., connected directly to it—and the circuit completed through the shaft and bearings and hull of the ship, and the third slip-ring dispensed with. This, however, is not good practice, as with the two way switch in the "test" position, two slip-rings would be inclined in the circuit, and when the switch was in the "reading" position only one ring would be in the circuit.

With the use of a third slip-ring, however, there are always two slip-rings in circuit in either the "test" or "reading" position, and any slight resistance there may be at the slip-rings is constant, and affects both circuits equally. The two-way battery switch is provided so that the battery may be charged, when desired, direct from the ship's electric circuit. When in the "charge" position it is connected to the ship's circuit, and when in the "discharge" position it is connected to the torsion-meter.

A semi-circular resistance wire mounted on an insulating base has been used as a shunt, with a contact-maker bearing upon it and carried by the base, the whole arrangement being carried by the resting-piece arm. A pinion fixed to the spindle of the contact-maker engages with a rack fixed to the sleeve-arm. The relative displacement of the arms is multiplied considerably by the gearing thus introduced, and a large travel of the contact-maker on the shunt obtained.

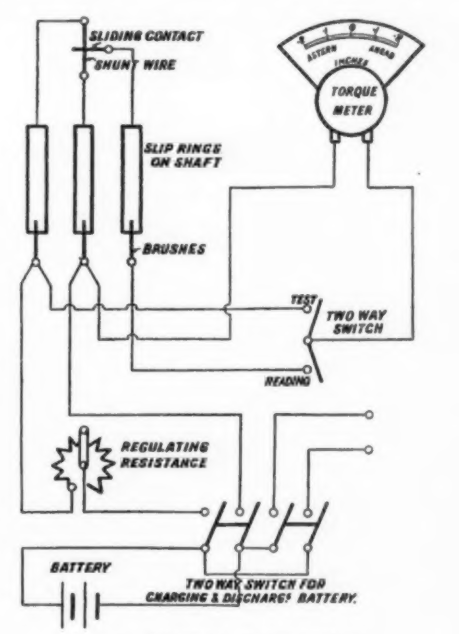


Fig. 4.—Diagram of Connections.

The special advantage claimed for this instrument is that it is quite independent of any displacement or distortion of any part of the hull of the vessel such as may occur in destroyers and other light high-powered vessels.

It is also an integrating meter, and therefore gives the true mean torque, and the torsion of stationary shafts can be measured by means of it, so that the shafts can be calibrated with their own torsion-meter before being placed on board. The horse-power is readily obtained from the torsion readings.

Cement for Driving Belts.—Five parts of sulphide of carbon and 0.5 part of oil of turpentine are mixed and as much gutta-percha gradually dissolved in it as will suffice to produce a paste. The pieces of leather are freed from fat by placing a rag on the surface of the leather and setting a hot iron on it, then both pieces are smeared with the above cement and exposed to pressure until the cement is dry.

Temperature Pendants

Convenient Means for Determining Flue Gas Temperatures

At the basis of all scientific management are quantitative measurements, and one of the most notable developments in modern steam plant practice is the introduction of all kinds of meters for weighing the coal, measuring the boiler feed water, determining the flow of steam, sampling the gases of combustion, recording the temperature of the water entering the boiler, measuring and recording the draft in the ashpit and in the chimney, and measuring the many other quantities that enable a steam plant engineer to compare his plant intelligently with other plants of the same class and to determine the magnitude of losses.

In the operation of a steam boiler, one of the most important quantities is the temperature of the gases passing to the chimney, since, other things being equal, this temperature is a direct measure of the portion of the heat of the fuel which is wasted or not utilized. If we assume a pound of coal having a heating value of 14,000 B.t.u. to be burned with 20 pounds of air, which is about the smallest ratio of air to coal found in actual commercial practice, the temperature in the furnace after complete combustion should be about 2,500 deg. Fahr. above the temperature of the atmosphere. The temperature of steam at 150 pounds gage pressure is 366 deg. Fahr. and if it were possible to transfer all of the heat in the gases above this temperature to the steam and water in the boiler, the efficiency of the boiler would be 88 per cent.

As a matter of fact, no boiler reduces the temperature of the gases to the temperature of the steam. To do so would require an infinite extent of heating surface, since as the temperature of the gases approaches that of the contents of the boiler, the rate of heat transmission per square foot of boiler surface per hour falls lower and lower, being proportional to the difference in temperature between the gases and the water in the boiler. There is therefore a limit to the amount of boiler surface that it pays to put in. Beyond a certain point the interest and charges on extra boiler surface amount to more than the value of the heat regained. Commercial practice some years ago established this limit of surface at about 10 square feet of boiler surface per boiler horse-power, but recent practice has shown that a boiler horse-power can be produced from much less surface, such as 3 to 5 square feet or even less, and in some plants it has become a matter of routine to drive the boilers at about 60 per cent above the nominal rating of 10 square feet per boiler horse-power.

Even disregarding the number of square feet of boiler heating surface employed to produce a boiler horse-power, it is found in commercial plants that the chimney gases escape at temperatures considerably above the steam temperature, such as 450 degrees to 500 degrees at least. This represents a waste of from 20 to 40 per cent of the heat of the coal, the amount depending partly upon the quantity of air used to burn a pound of coal. In a 1,000 horse-power plant running 24 hours per day, 360 days per year, with a load factor of 50 per cent, and burning coal costing $2.50 per ton, a 25 per cent waste of coal amounts to $6,000 per year, not including charges for handling coal and ashes, therefore some little time and study to determine the extent of the waste in any given case is well justified.

The usual and most practicable way of recovering waste heat from chimney flue gases consists in the use of an economizer, the heating surface of which, because of the lower temperature of the contents, is much more active in absorbing heat than an equal amount of surface in the last pass of the boiler. That is, since the economizer receives water at a temperature of 80 degrees to 150 degrees and discharges the water at 200 degrees to 300 degrees, with an average temperature for the whole economizer of 200 deg. Fahr. to 220 deg. Fahr., say, it is able to absorb about twice as much heat from 500 deg. Fahr. gases as can the boiler surface.

Obviously, the advisability of putting in economizers or of making other changes in the equipment depends to a large extent upon the actual temperature of the gases as they leave the boilers. In some cases this temperature is much higher than in other cases where approximately the same amount of coal is being burned on grates of the same type and the boilers are driven at the same rating. In such cases it usually turns out that the low temperature is also accompanied by a large excess of air, and the efficiency of the boilers delivering low-temperature gases is, more often than not, lower than that of boilers delivering high-temperature gases. The temperature of the flue gases is, therefore, an essential factor in checking the proper operation of the furnaces, tightness of setting, etc., as well as for calculating the heat available for recovery.

Indicating and recording thermometers and pyrometers are sometimes put in for measuring the temperature of flue gases, but their use is not general, owing partly to their cost and also to the fact that many types of instruments are not reliable or break down in service. There is, therefore, a demand for cheap and efficient means of determining flue gas temperatures, which a manufacturing firm of Matteawan, N. Y., has met by devising the temperature pendants shown herewith. These consist of fusible alloys of the proper composition to indicate the desired temperatures.

It is an interesting fact that the melting points of such metals were found to be too uncertain to be used as temperature tests. That is, it is difficult to tell the exact point at which the metal melts, since it does not change suddenly from a hard solid to a liquid, as does water, but goes through an intermediate softening stage similar to iron and many other substances.

A firm of manufacturers of fuel economizers therefore devised the expedient of using the tensile strength of the metal, instead of the melting point, as the true indication of temperature. In other words, the pendants are made with a large body, having a certain definite weight, suspended from a narrow neck, and the composition of the metal and cross section of this neck are adjusted until the body of the pendant will pull the neck in two and fall at some desired temperature.

In actual use the pendants are hung upon a small hook made upon the end of a long wire, which is introduced into the flue so that the pendant will be at the desired point. The best way is to begin with the lowest temperature pendant, and proceed until the one is found which will not fall off after 5 or 10 minutes exposure. The temperature will then lie somewhere between the temperature marked on the last pendant and the next to the last pendant used. In doing this, it is quite essential that several different points in the flue be tried, as it very frequently happens that one part of the flue is occupied by gases much hotter than the gases in other parts of the flue.

At present, pendants for temperatures of 425 deg., 500 deg., and 550 deg. Fahr. are made, these three points representing respectively the temperature at which the use of the economizer is justified with coal at commercial prices, the temperature at which an economizer is a good investment in all cases, and the temperature at which neglect to install an economizer becomes an inexcusable waste.

For use in connection with these pendants the manufacturers of the pendants have calculated three tables which we reproduce herewith. The first, as will be noted, shows the percentage of heat escaping in chimney gases at various flue temperatures, assuming 26 pounds of air and 14,500 B.t.u. per pound of coal. The second table gives the minimum temperature to which it pays to cool the gases by means of boiler surface only; and the third, the minimum temperature to which it pays to cool the gases by means of an economizer. These tables are based upon an investment of $15 per nominal boiler horse-power in the boiler and $5 per nominal boiler horse-power in the stoker, grates, and draft apparatus, interest at 5 per cent, and sinking fund and maintenance charges at 12 per cent. The figures for the economizer are based on $1 per square foot and annual charges for interest, depreciation, maintenance, power, and attendance at 12 per cent, the economizer being notably longer lived and requiring less care and attention than the boiler.

The minimum temperature between the gases leaving the economizer and the temperature of the water entering the economizer which it pays to have in any case not covered by the tables may be calculated from:

E

$$D = U \times Y_e \left(\frac{B \times S}{33{,}300 \times Y_b} + \frac{C}{2000 \times N_s \times H} \right).$$

B = annual charge in dollars on 1 square foot of boiler surface, including interest, maintenance, depreciation, and labor.

E = annual charge in dollars on 1 square foot of economizer surface, including interest, maintenance, depreciation, and labor.

Y_b = hours per year that the boilers are operated.

Y_e = hours per year that the economizers are operated.

C = cost of coal per ton in dollars, including handling of the coal and ashes.

H = heating value of the coal in B.t.u. per pound.

S = square feet of boiler heating surface per boiler horse-power developed.

N_s = efficiency of the boiler when operated at S square feet per boiler horse-power developed.

U = coefficient of transmission per square foot per hour per degree difference of temperature between the gases and the water.

The manufacturers advise us that they will be pleased to send samples of these temperature pendants to any one connected with a steam plant who would be interested in determining the temperature of flue gases.

TABLE 1.—Percentage of Heat Escaping in Chimney Gases at Various Flue Temperatures, assuming 26 Pounds of Air per Pound of Coal, and 14,500 b. t. u. per Pound of Coal.

Chimney Temperature Degrees Fah.	B.T.U. in Gases Per Pound of Coal	Percentage of Total Heat in Gases	Ratio of Heat in Flue Gases above 60 deg. to heat absorbed by boiler, assuming 15% Loss through Grates and Radiation, per cent.
200	905	6.25	8.
300	1555	10.7	14.4
400	2200	15.2	21.8
500	2850	19.68	30.2
600	3500	24.1	39.6
700	4150	28.6	50.6
800	4790	33.0	63.4
900	5440	37.5	79.0
1000	6090	42.0	97.5

TABLE 2.—Minimum Economic Temperature of Gases Leaving the Boiler, Operating 3100 Hours per Year.

Price of Coal Per Ton	Cost of Boiler Horse Power Year	Critical Temperature Difference Degrees Fah.	Economical Temperature of Gases leaving Boiler. Pressure=150 lbs. gauge, Degrees Fah.
$2.00	$14.25	319	685
2.50	16.97	268	634
3.00	19.68	231	597
3.50	22.40	202	568
4.00	25.10	181	547
4.50	27.80	163	529
5.00	30.50	149	515

Operating 8760 Hours per Year.

Price of Coal Per Ton	Cost of Boiler Horsepower Year	Critical Temperature Difference Degrees Fah.	Minimum Economical Temperature of Gases, Boiles Pressure=150 lbs. guage Degrees Fah.
$2.00	$34.10	133	499
2.50	41.70	109	475
3.00	49.40	92	458
3.50	57.10	80	446
4.00	64.70	70	436
4.50	72.40	63	429
5.00	80.00	57	423

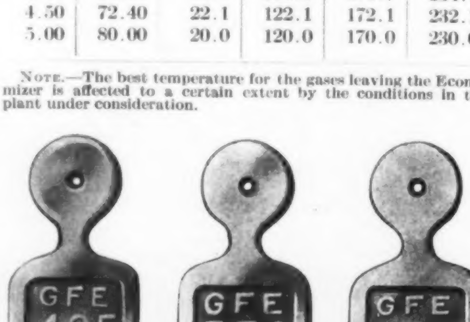
Table 3.—Minimum Economical Temperature of Flue Gases for Different Prices of Coal for an Economizer Plant Operating 10 Hours per Day and 310 Days per Year.

Price of Coal.	Cost of Boiler Horse-Power, Year.	Critical Temperature Diff.	Temperature Flue Gases Leaving Economizer for Various Temperatures of Feed Water, degrees.		
		Deg. Fah.	100 Deg.	150 Deg.	210 Deg.
$2.00	$14.25	112.2	212.2	262.2	322.2
2.50	16.98	94.5	194.5	244.5	304.5
3.00	19.68	81.4	181.4	231.4	291.4
3.50	22.40	71.5	171.5	221.5	281.5
4.00	25.10	63.8	163.8	213.8	273.8
4.50	27.80	57.5	157.5	207.5	267.5
5.00	30.55	52.5	152.5	202.5	262.5

For Economizer Operating 24 Hours per Day and 365 Days per Year.

$2.00	$34.10	47.0	147.0	197.0	257.0
2.50	41.75	38.3	138.3	188.3	248.3
3.00	49.40	32.4	132.4	182.4	242.4
3.50	57.10	28.0	128.0	178.0	238.0
4.00	64.70	24.7	124.7	174.7	234.7
4.50	72.40	22.1	122.1	172.1	232.1
5.00	80.00	20.0	120.0	170.0	230.0

Note.—The best temperature for the gases leaving the Economizer is affected to a certain extent by the conditions in the plant under consideration.



Temperature Pendants (Exact Size).

The Estimation of Ore Reserves*

A Practical Method of Gaging the Extent of a Deposit

By Frank H. Probert and Roy B. Earling

THE following practice has been adopted at the Ray Central property, at Ray, Ariz., for estimating tonnage and value of ore developed. Inasmuch as the method can be applied at any property where disseminated ores are developed it is worthy of detailed description.

CO-ORDINATE SYSTEM OF DESIGNATING WORKINGS.

The property has been laid out and all work done along rectangular co-ordinates, all workings being numbered according to the distance in either direction from the zero point, for example, *N* 400-*E* 600-*E* is a drift driven east from a point *N* 400 *E* 600. All drifts and cross-cuts are run along these co-ordinates with winzes and raises connecting levels at points of intersection. In this way the orebody is first split into 200-foot blocks to be later subdivided. Cross and longitudinal sections at intervals of 100 feet and level plans are used in the computation, upon which are plotted all underground workings, churn-drill holes, assays and major geological features. The standard scale used is 50 feet to the inch. All maps are brought up to date at the end of each month and blueprints showing progress, accompanied by the report of the engineer, are forwarded to the respective officers of the company.

Low-grade ores require constant and accurate sampling. The copper occurs as finely disseminated particles of chalcocite, chalcopyrite, oxide or native in a siliceous schist, or occasionally in the intrusive rocks to which the orebodies owe their origin. To distinguish between commercially mineralized schist and waste is impossible except by careful sampling. All underground openings, whether in ore or country rock, look monotonously alike, hence the necessity for accurate sampling and assay maps.

Samples are taken in 5-foot sections starting from a co-ordinate or transit point, care being taken to first clean down the walls. A continuous groove 1½ inches deep and 3 inches wide is cut in each wall. Particular care is taken to secure about the same amount of material from every part of the 5-foot section to prevent the enrichment of the sample by any small seam of high-grade ore which might occur. About 35 pounds are taken per sample. As the drift advances the groove is continued. The samples are sacked underground, dried, crushed, quartered in split dividers and the final pulp put up in duplicate, one for permanent filing, the other for immediate assay. All determinations are made by electrolytic assay, the apparatus being of the rotating-anode type. The results are recorded on the maps and complete numerical and classified card files are kept in the fireproof vault at the mine office. To avoid the possibility of error, frequent check samples are taken in stretches of from 50 to 100 feet. The laboratory work is also checked by composites and re-assaying of individual samples.

MEASUREMENT OF TONNAGE.

The first step in computing tonnage is to define the workable limits of the orebody on the several maps, taking each set of sections separately. Local economic conditions naturally determine the minimum grade that can be profitably mined, so that in sketching in the areas of commercial ore the limits are defined by the assays. Any marked irregularity is, of course, avoided, the object being to outline the orebody as it will be mined. A run of low-grade assays will often be included in a block while a small tongue of high-grade might have to be discarded from the calculation. If a working has been discontinued in ore, an allowance is made for the probable extension of the orebody a distance of from 5 to 50 feet, depending on the proximity of other workings, the uniformity of the ore and geological conditions. Here the personal equation of the engineer figures in the estimate and intimate knowledge of the district is necessary.

Each set of sections is compared and correlated with the other sections and plans and altered so that they represent a definite orebody of concrete form. Areas are always reduced rather than added to in making the sections conform. Figs. 1 and 2 are reductions of actual sections used in the computation recently made for the shareholders of Ray Central.

ORE MEASURED IN 200-FOOT BLOCKS.

The cubic content of the orebody is now determined by taking blocks 200 feet square, of variable depth, designated by the co-ordinates between which they lie, viz., *N* 200-400, *W*., 0-200. At Ray Central longitudinal and cross-section maps are available at intervals of 100 feet so that in calculating any given block, six sections have to be used, three north-south and three east-west as shown in Figs. 3 and 4. These maps show the sectional area of the orebody on each face and through the middle of the block, the areas being measured either by planimeter or by counting the squares on cross-section tracing cloth superimposed on the map, and multiplying by the factor necessary to give square feet. Taking either set of three sections the volume of the block is calculated by the prismoidal formula, which is:

$$V = L\ \frac{E+4C+E'}{6})$$

Where V is the volume, E one end area, E' the other end area, C the area of center section, and L the length. Inasmuch as there are two entirely separate sets of sections, north-south and east-west, two results are obtained for the volume of each block, which should be approximately the same. If the conditions are such that the two sets of sections should give equally correct results, the average of the two is accepted as the volume of the block. For full blocks 200 feet square the measurement of volume is simple, but irregular fractional blocks on the edge of the orebody can not be as accurately estimated. Where owing to the form of the block, three faces are presented by one set of sections and only one or two by the other set, the result obtained from the first series is accepted.

Throughout the Ray District the ratio of 12½:1 is used in the conversion of volume to tonnage. The total tonnage is obtained by adding together the tonnages of the individual 200-foot blocks.

CALCULATION OF AVERAGE GRADE.

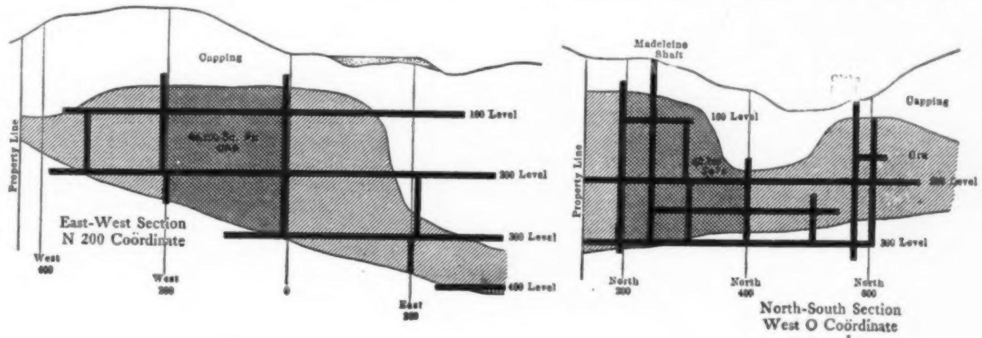
The average grade of the orebody thus delimited is determined by the average assay values of the individual blocks. In a block containing both high- and low-grade ore, irregularly distributed, it is obvious that an arithmetical average of all assays in such block would be incorrect. Due weight must be given to each run of assays according to the number of times it figures in the computation.

Referring to Fig. 5, if all assays were given the same weight in computing the value of block *A*, and subsequently the assays in block *B* were averaged to give the value of that block, then the assays in drift No. 2, which is on their common line, would be used twice, while those in drift No. 1 would be used only once. In the same way after all adjacent blocks had been figured the assays in winze No. 3 would have been used four times. In other words the assays in workings along co-ordinates would have twice the representation and those in the winzes and raises at the intersection of co-ordinates, four times that of the interior workings and unless this is guarded against the results can not be accurate.

It is, therefore, necessary in order that each assay have the same representation in the final result that they be given different factors in individual blocks, as follows:

All assays in interior of a block, a factor of 4
All assays on side faces of a block, a factor of 2
All assays at corners of a block, a factor of 1

In estimating the value of the Ray Central orebody the ratio of ½, 1 and 2 is used, instead of 1, 2 and 4 to facilitate the work, viz., 46 assays in drifts along a co-ordinate line totaling 116.07 are figured as such, whereas 103 samples giving 217.78 from winzes at the corner of a block figure as 51½ samples of 108.89, so that in the block shown, instead of having 488 samples totaling 1,027.98, we figure 511½ samples giving an assay total of 1,027.57 making the average assay for the block 2.098 per cent.



Figs. 1 and 2.—Typical Sections of the Ray Central Orebody.

The general assay of the whole orebody is obtained by adding the "tons per cent" of component blocks and dividing by the total tonnage. Summarized the estimation involves:

(1) Computation of tonnage for individual 200-foot blocks by prismoidal formula.

(2) Computation of average assay for individual blocks with assay factors according to situation.

(3) Computation of total tonnage by addition of block tonnages.

(4) Computation of general average assay, using factors for block averages according to tonnages.

All block tonnages, assays and computations are kept in a loose-leaf book on special forms, Fig. 6, provided for the purpose.

The Transformation of Metals by Lamination.—A curious observation has been made in forcing metals in a very thin layer through an aperture. It is found that the lamina so formed exhibits a beautiful crystalline structure and a highly abnormal tenacity. This is true in particular of zinc, whose tenacity is increased 190 times. Similar observations have been made with aluminium, copper and lead.—*Cosmos.*

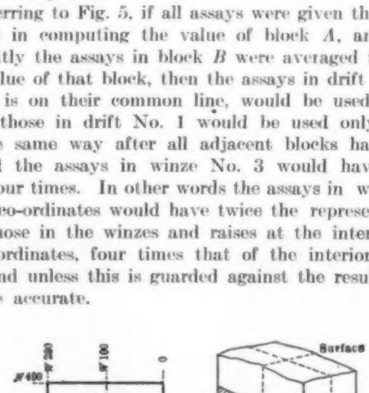


Fig. 3 Plan of 200-ft. Block Fig. 4 Fig. 5 Plan

DIAGRAMS OF 200-FT. BLOCKS OF ORE

DATE Jan. 1, 1911 CLASS Actual
ENGR. . . . . BLOCK N 200-400 W 0-200

	Section		Area in Square Feet	Total
E-W SEC.	N200 300 400	33,500x4	44,200 134,000 14,200	

$$192{,}400 \times \frac{200}{6} = 6{,}412{,}000$$

N-S SEC.	W 0 100 200	32,000x4	40,700 128,000 20,700	

$$189{,}400 \times \frac{200}{6} = 6{,}313{,}000$$

ACCEPTED (ave.) 6,362,000 cu.ft.
509,000 tons

ASSAYS

Map	No.	Total	Factor	No.	Total
100′ lev....	73	146.72	1	73	146.72
200′ lev....	63	127.24	2	126	254.48
	115	244.09	1	115	244.09
250′ lev....	54	103.17	1	54	103.17
300′ lev....	22	46.67	1	22	46.67
Sections...	103	217.78	½	51½	108.89
...	46	116.07	1	46	116.07
...	12	26.24	2	24	52.48

TOTAL 511½ 1027.57
AVERAGE ASSAY 2.098 per cent.

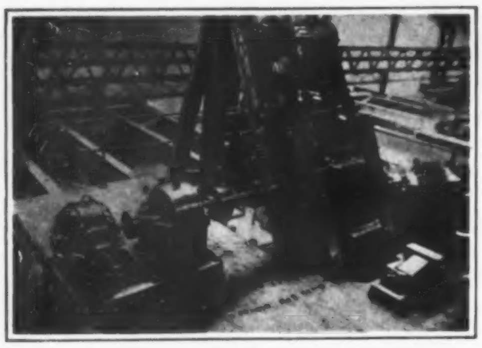
FIGURE 6

* Reproduced from *The Engineering and Mining Journal.*

Salt Manufacture in Great Britain

A New Plant Working by Vacuum Evaporation

By our English Correspondent



Head of Elevator Which Lifts the Salt from the Evaporators to the Cars.

For some years past the salt industry of Great Britain has been dwindling steadily owing to spirited competition from other parts of the world. A quarter of a century ago this product enjoyed the monopoly of the Eastern and Indian market, but to-day the exports are about one-half of what they were at the time, having shrunk from 358,000 to 180,000 tons in twenty-two years.

Several adverse factors have contributed to this result, the greatest being the establishment of salt fields on the shores of the Mediterranean Sea and at other points where the salt is extracted from sea water by solar evaporation, the development of the tramp steamer, and the fact that the salt works of England are all situated some distance from the point of shipment, thus entailing heavy transport charges by rail. Added to these circumstances comes the fact that the system of manufacture was somewhat uneconomical, the result being that the British Salt Union—an amalgamation of the firms engaged in this enterprise—could not compete with its rivals in point of prices.

A determined effort is being made however to retrieve the lost position. A new plant has been laid down recently which is of the most economical manufacturing character and which contains many interesting features. Moreover, the center of manufacture has been established upon the seaboard near Liverpool so that the railway transportation charges for the finished product may be saved, together with numerous other incidental expenses in the cost of production.

In England salt is found in enormous quantities in certain parts of Cheshire at varying depths below the surface in the form of brine. The center of this great subterranean salt bed is around Droitwich and Northwich, colloquially known as the "wiches." The deposits are practically inexhaustible, for although many million tons of brine have been pumped up there appears to be no signs of exhaustion or even depreciation in the saline contents of the liquor. The general method of recovering the salt has been to evaporate the water in an open pan plant fired by Mond gas and coal.

The new plant which has recently been completed at Weston Point, on the Manchester Ship Canal is designed to work upon the triple-effect vacuum evaporation system which is far the cheapest and most economical. The evaporators are among the largest, if not the largest, that have ever been built for this work, the capacity ranging from 150,000 to 200,000 tons of salt per annum. The installation has been carried out by a Glasgow engineering firm, the Mirrlees Watson Company, to whose courtesy we are indebted for the information and photographs accompanying this article. In addition to the production of the salt, the plant is designed to produce caustic soda in large quantities for a new and special process adopted at Winsford, another establishment belonging to the Union, for the manufacture of chemically pure salt for special purposes.

The Weston Point works receive the brine from the salt beds in Mid-Cheshire through a pipe line 12½ miles in length, which is of sufficient capacity to meet the requirements of the new evaporating installation. The evaporators are housed in a large building measuring 120 feet in length by 114 feet in width. The evaporators shown in the accompanying illustration, each measure 66 feet in height by 26½ feet in diameter. The three evaporators are placed in line and the principle of operation is as follows:

Whereas brine in the open air boils at a temperature of 226 deg. Fahr., when the operation is carried out in a vacuum of 28 inches of mercury, ebullition takes place at 100 deg. Fahr.

Each pan is charged with salt brine, for the deposit of the saline content in the liquor takes place in each vessel. Each of these accordingly has to be fitted with means for admitting the liquor, and for the removal of the precipitate as it forms. The brine, as it arrives from the beds through the pipe line, is led to a feed tank. From this point it is passed through preliminary heaters which raise the temperature of the brine from 58 to 140 deg. Fahr. at the rate of 100 tons of brine per hour. The supply of liquid is maintained by a pump capable of delivering 400 gallons per minute. The heated brine is charged into the vacuum evaporators by means of a powerful electrically driven pump delivering about 3,900 gallons per minute.

When the vessels are charged with brine to the requisite level, exhaust steam from the engine plant of the works is admitted to the first vessel. Its entrance is controlled by a 28-inch valve. This first vessel is also fitted with a high pressure steam pipe, while by-pass pipes are also provided, for the purposes of warming up when starting from cold. The highest temperature is maintained in the first vessel the brine in which becomes heated up very quickly. The steam given off in this operation enters the second vessel where the temperature of the brine is likewise raised. After the steam has accomplished its work in this second evaporator, it is condensed, with the result that a partial vacuum is created in the first vessel. As the pressure of air in the latter has thus been reduced the brine in the first vessel boils violently. As the brine in the third vessel acts as a condenser of the vapor and therefore creates a partial vacuum in the second evaporator, ebullition similar to that in the first vessel ensues. The steam emitted in the third pan by the boiling of the brine is condensed by a jet condenser of the barometric pattern. It is 62 feet in height by 10 feet in diameter and is capable of condensing 60,000 pounds of steam per hour, for which purpose 330,000 gallons of circulating water per hour are required. It will be observed that in the first evaporator the highest temperature and lowest vacuum prevail, while the lowest temperature and the highest vacuum are found in the third vessel.

Each evaporator is fitted with agitators to keep the brine in motion during the evaporation process. These propeller-stirrers are driven by means of electric motors through gearing running in oil baths. As the salt is precipitated to the bottom of the pan which is of conical shape, ending in elevator boots, it is dredged up continuously through up-takes which are cast iron trunks charged with brine to maintain an air-tight seal to the evaporating vessel. Each vessel has its own elevator with a capacity of a trifle more than 8 tons per hour, and is driven by an 8 horse-power electric motor. The wet salt, the brine from which drains back into the evaporator, is raised to a platform and discharged into wooden trucks. These wagons of 5 tons capacity are of special design, built from the plans of Mr. Malcolm, the engineer to the Salt Union, under whose supervision the entire plant was prepared and erected, the shape being that of an inverted V in section so as to permit the salt to escape freely. The floor of the wagon is perforated to enable the drainage brine to escape into the feed tanks below the platform, and from this point the salt is conveyed to the storehouse to await shipment. The storage house is a large building 300 feet in length by 88 feet in width, on the floor of which the mineral is dumped. An overhead electrical equipment is provided for the handling of the salt. Conveyors stretch from one end of the house to the other. The salt is shovelled on these conveyors to be carried off and delivered into two bucket conveyors installed in two towers, whence the product is conveyed and discharged through special chutes directly into the holds of vessels moored alongside the quay.

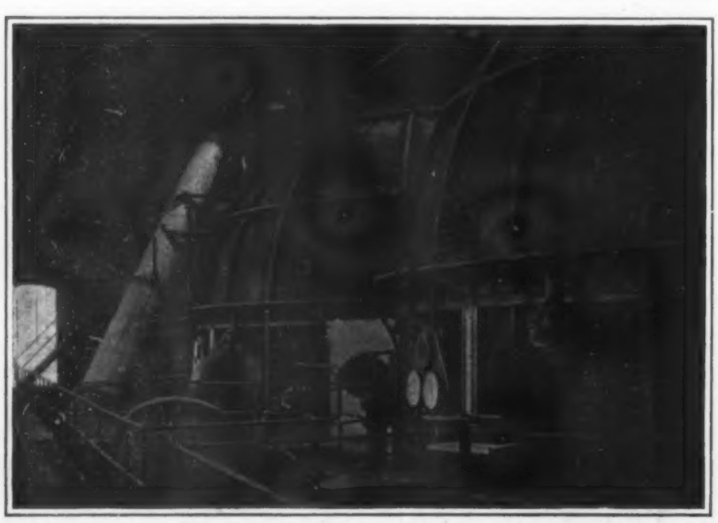
Heaters in Which the Brine is Heated from 58 deg. to 140 deg. Fahr.

The whole of the work and the numerous subsidiary operations are carried out electrically, the equipment being of the most up-to-date description, so that manual labor is reduced to a minimum. The greater part of the electrical equipment is controlled from a platform in the vacuum evaporation building. The evaporators are fitted with a very complete equipment of pressure gages and thermometers in order to keep the operation of the vessels under perfect control.

The water resulting from the evaporation of the brine in the vessels 1 and 2 is collected in a large tank to be used for washing out the vessels during cleaning, for the fire extinguishing service, and so forth, but the exhaust and live steam from the first pan is condensed and returned to the boilers as feedwater.

The salt though of commercial value is impregnated with certain impurities—magnesium chloride and calcium sulphate—which renders it unsuitable and detrimental for curing and dairy purposes. A new and ingenious process has been brought into operation by the Salt Union for the production of chemically pure salt suited to these requirements at one of their other works. For this process caustic soda is required which is produced at Weston Point for later conveyance to Winsford.

By means of this complete and economical modern plant the Salt Union hopes to regain a considerable amount of its lost business. The cost of manufacture has been reduced to a figure which enables it to compete successfully with the solar evaporating salt beds in southern Europe, while producing a superior article.



General View of the Working Side of the Evaporators.

Top View of the Three Evaporators.

THESE EVAPORATORS MEASURE 66 FEET IN HEIGHT AND 26½ FEET IN DIAMETER.

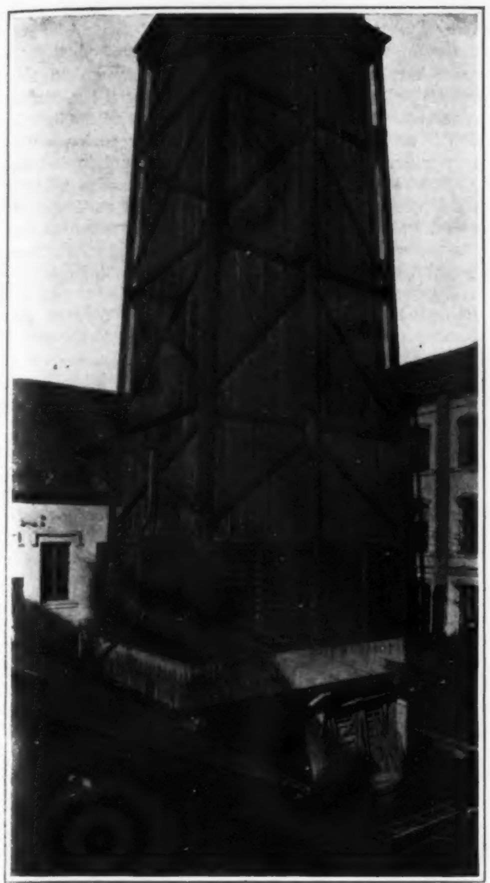


Fig. 2—Woodwork "Chimney" Cooler. Capacity, 2,800 Cubic Feet Per Hour.

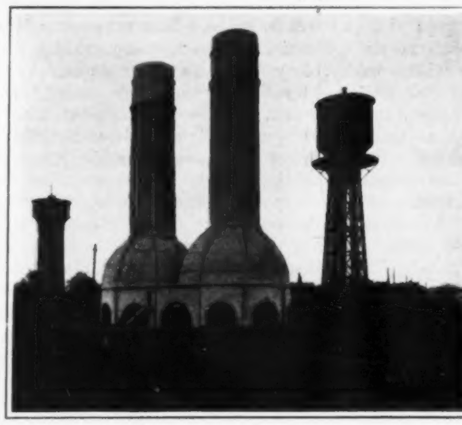


Fig. 1—Concrete Cooling Towers—Zschocke System.

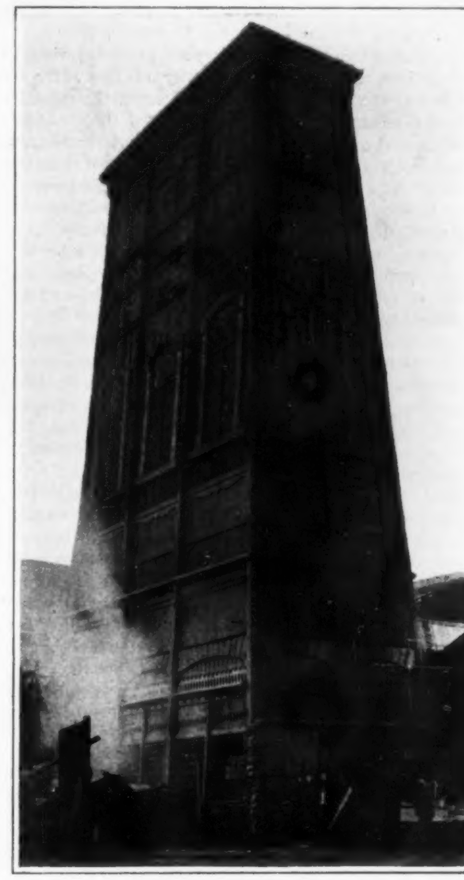


Fig. 3—Decorated "Chimney" Cooler of Wood Construction. Capacity, 7,800 Cubic Feet Per Hour.

Modern Water Coolers for Factories

One Form of Fuel Economizers

By our Berlin Correspondent

It is well known to the industrial engineer that the use of a proper condenser in combination with a steam engine or turbine effects a very material saving in fuel consumption. In many cases, however, the difficulty of obtaining a constant and ample supply of cooling water has formed a serious, if not unsurmountable, obstacle to the introduction of a condensing plant.

This difficulty, however, no longer stands in the way of steam users profiting by the advantages of condensing, since it is now possible, with re-cooling grids, to use the same water over and over again and maintain it in constant circulation between the condenser, where it is heated, and the re-cooler, where its temperature is again lowered.

Attempts have been made to use brushwood re-coolers, such as are employed at salt works. This device acts fairly well for a short time, but after a while the rind of the twigs peels off and obstructs the air passages to such an extent as to prevent efficient cooling. The smaller twigs also become rotten, and have to be renewed at frequent intervals; and there is constant risk of falling twigs and rind getting into the condenser and causing stoppages.

It is claimed that all these defects are obviated by the modern re-cooling plant, in which the water is distributed by means of a specially constructed and solidly built internal device, which insures uniform re-cooling at all times.

The re-cooling plants used in Germany are of four types, according to local conditions, and include open coolers, tower coolers, underground coolers and fan coolers. According to local conditions the casings of the tower, underground and fan coolers are of wood, iron, stone or concrete, either in a simple or decorative design. The plants are for normal re-cooling, from about 112 to 120 deg. Fahr., to 77 to 78 deg. Fahr., or for specially low re-cooling down to 61 deg. Fahr. The high efficiency of the re-cooler is obtained by the perfectly uniform distribution of the water, in thin strata, over exceptionally large cooling surfaces, and by the unrestricted access of air to these surfaces and the drops of falling water. This system is also applied to the elimination of iron from water, and to the aeration of well water and effluent waters. The re-cooling plant operates as follows: The heated water from the condenser is discharged from the delivery pipe of the condenser or pump into a distributing trough at the top of the cooler, and flows thence into a number of branch troughs varying with the size of the plant. From these troughs it passes through a large number of delivery pipes into the distributing boxes underneath. Overflowing the nicked longitudinal edges of these boxes, the water collects into drops at the serrations below and falls thence on to the grids.

Fig. 4.—Gridwork Filling of Cooling Towers.

As soon as the drops come into contact with the grid-bars which, owing to their large number, afford a more extensive cooling surface than is obtainable by any other system, they unite to a thin film, which in turn collects in the form of drops, at the serrations on the bars, whence the water falls on to the next lower grid, and so forth, the operation being repeated at each grid in turn.

In this way a kind of uniform rain is formed throughout the whole of the cooler. The ascending air being compelled to flow through the grids in the opposite direction to the course taken by the water, and to absorb heat from each drop of water, as well as from the films on the extremely large cooling surface of the grids, an energetic cooling effect is obtained.

In plants for re-cooling the condensing water from steam engines and turbines, a simple form of oil separator is used, which is arranged over the main distributing trough. The water to be cooled is discharged into the oil separator, where the flow of the upper stratum of water is checked by a partition, which retains the oil and other light impurities floating on the surface,

Fig. 5—Set of Wooden "Chimney" Coolers. Capacity, 11,300 Cubic Feet Per Hour.

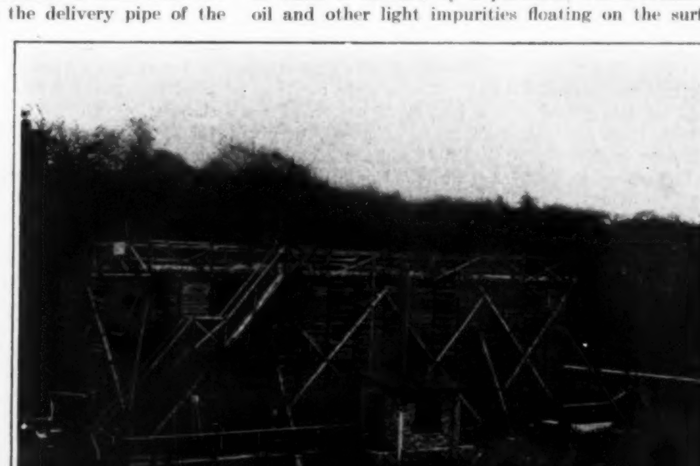


Fig. 6—Open Cooler. Capacity, 4,250 Cubic Feet Per Hour.

and allows only the clarified water to pass away underneath.

Of course, this separation is only partial, owing to the vortices caused by the velocity of the water on entering the separator, and on this account the specially shaped discharge pipes at the bottom of the separator are arranged at such a level as to prevent the outflow of either the oil collected on the surface or the heavy dirt and sand deposited at the bottom. This arrangement insures that clear water alone finds its way into the main distributing trough. This appliance keeps the cooling surfaces free from oil, which would otherwise be a source of inconvenience and retard cooling, and at the same time it protects the rubber valves of the condenser from damage by the oil.

The open cooler has the advantage of low cost of construction and of requiring very little foundation. Its lightness enables it to be mounted on a roof in places where space is scanty. Since, in the absence of wind, the vapor given off from the cooler hangs about, this type of cooler requires a considerable open space, to prevent adjacent buildings from being affected by the vapors. Aside from the grids and the overlying system of distributing troughs, there are none but the simplest structures, the outside being surrounded with louvers, to prevent the water from spurting or blowing away.

The tower cooler can be employed with advantage where space is a consideration, for instance, where the plant has to be put up in a narrow yard. The internal arrangement is exactly the same as that of the open cooler, the only difference being that the casing is in the form of a tower, made of strong, rectangular, wooden uprights, with diagonals and ties, firmly bolted together, the whole being lined air tight, with planed, tongued and grooved boarding. The tower acts like a chimney stack, the air, warmed by the water, ascending with considerable velocity, and thus causing energetic evaporation of the water. The vapors issuing from the top of the tower pass away over the adjacent buildings, so that no inconvenience is caused to the neighborhood. The height of the tower depends on that of the surrounding buildings, and may range from 50 to 80 feet. With this type it is impossible for the water to be scattered or blown away. The efficiency of the open and tower types is said to be identical. Recently a practice has arisen of employing circular coolers with iron casing, but these are relatively uneconomical owing to their higher first cost, the life of these iron coolers, the casing of which is about ¼ inch thick, being very little longer than that of a properly constructed wooden casing.

All of the finished parts of the wooden coolers are impregnated with hot carbolineum of the best quality before leaving the works, this treatment greatly increasing the resistance of the timber to atmospheric influences. In some cases the cooling plant is provided with an iron casing, also with iron frame and wood-lined towers, the cost of which, however, is high. The underground cooler is employed in order to utilize the condenser vacuum for raising the water, and to save the expense of a separate pump for that purpose, the water flowing directly from the condenser to the cooling plant. The internal arrangement and method of distributing the water are the same as in the tower above ground. The requisite draught is obtained by means of a casing and the re-cooled water is automatically drawn off (to a distance of about 20 feet) by the condenser vacuum. No pump is needed for raising the water up to the cooler with this type of plant. On the other hand, a larger floor space is required than for the ordinary tower cooler; and since the apparatus is below the level of the ground, the cost of the foundation is considerably increased. The fan cooler is used only where space is readily available, and in hot districts. The requisite amount of air for cooling is blown in by means of one or more fans, so that motive power is required. The cost is very much the same as that of a tower cooler of equal capacity, working with natural draught. The dimensions of the fan cooler are relatively smaller but on the other hand, owing to the permanent consumption of motive power for the fan, the working expenses are higher than with tower coolers and natural draught; and owing to the greater height of the structure, more powerful pumps are necessary.

In the accompanying illustration Fig. 1 shows two concrete cooling towers of the Zschocke type. Fig. 5 is a set of chimney coolers of wood construction with a capacity of 320 cubic meters per hour as utilized by the Gewerkschaft Deutscher Kaiser at Bruckhausen on the Rhine. The illustration Fig. 6 shows an open cooler of a capacity of 120 cubic meters of water per hour in service at Hannover at the plant of the Deutsche Grammophon A. G. and in Fig. 3 is seen a decorated chimney cooler of wooden construction at the power plant of the Kaiser's Kaffeegeschaft Works at Viersen. The wooden chimney cooler noted in Fig. 2 at the works of Bernhard Escher, Chemnitz, has a capacity of 80 cubic meters per hour. The gridwork of the Zschocke cooling plant is shown in illustration Fig. 4.

Armor for Ships*

A Review Over the Period 1860-1910

By Charles E. Ellis, Honorary Treasurer of the Institution of Naval Architects

THE period under review practically coincides with the history of the use of armor, and its manufacture for ships of war, from its inception to the present time. As will be seen, there has been an unbroken struggle for ascendency between the weapon of attack and the material produced to resist it, the advantage now lying with one side and now with the other, the most gratifying features being that it is a story of continuous development on both sides, modifications and improvements in ordnance necessitating and suggesting modifications and improvements in armor, and *vice versa*. My object is merely to set out, historically, the principal features of the various types of armor, during the period in question, from which the modern plate has been evolved.

In the year 1860 there were under construction in France and England the first two armored sea-going battleships, the "Gloire," building at Toulon, and the "Warrior," at Blackwall, the former having broadside protection of 5 inches, the latter similar protection of 4½-inch iron plates. Of the two vessels, the "Gloire" was commenced in March, 1858, the Blackwall ship being ordered in June, 1859. The use of armor in the two navies, for all important vessels, was subsequently uninterrupted, and in this country armor was gradually increased in thickness until it culminated in the maximum of 24 inches of armor fitted on the sides of the "Inflexible" (1881).

Prior to 1860, a large number of experiments connected with the manufacture of iron armor plates had been made, the thickness varying from ½ inch to 4 inches, and plates of this material, of varying dimensions, had been fitted to floating batteries in many countries of the world. It is somewhat difficult to state positively the names of the firms who were most successful at this period of the history of armor. I am inclined, from the materials at my disposal, to give the honor in France to the St. Chamond Company, and in England to the firm of Beale & Co., of the Parkgate Iron Works, near Rotherham. The former company held practically the monopoly of iron armor manufactured in France for a considerable period—1855 to 1870—and I am informed that their success was mainly attributable to the pure quality of their iron, and to the fact that, contrary to the general opinion, their plates were much improved by water treatment. In England, the competition was much more severe, various makers competed against one another, both with rolled and hammered plates, with varying success, and in a paper written by Capt. Inglis in 1862, giving a full account of various trials, the following are some of the practical conclusions which he laid down as the result of his investigations:

1. Good, tough wrought iron of high elasticity, but not necessarily of the highest ultimate tensile strength, is the best material for use in iron defences.

2. Rolled iron, though not perhaps equal in resistance to the best hammered iron, has such great advantage as to cost, if used in simple forms, as to justify its use when lightness is not of extreme importance.

3. In plates of ordinary dimensions, the resistance to cannon shot varies in proportion (approximately) to the square of the thickness of the plate.

4. Rigid backing is immensely superior to elastic backing, so far as the endurance of the front face is concerned.

5. The larger the masses,† and the fewer the joints, the stronger the structure, so long as the limits of uniform and perfect manufacture are obtained.

It is curious to note, in passing, how many of the conclusions of this eminent officer have been found to be applicable to nearly all the subsequent kinds of armor fitted for the protection of war vessels. I should like to quote here the opinion of another distinguished authority, Capt. Dyer, on the results of the same experiments about the same period.

1. Plates of hard crystalline structure are inferior to those of a soft fibrous nature.

2. The great weakness in forged plates is unsoundness in welding.

3. The quality necessary for an armor-plate is ductility. The purer and better the iron is, the more this quality is perceptible: any impurity or alloy hardens the metal and produces brittleness.

Rolled armor, was in the end, adopted for use in all the ironclad vessels for the British navy, including the "Warrior." The following description of the method of manufacture, given at this period, is of interest: "Several bars of iron were rolled 12 inches broad by 1 inch thick, and were cut 30 inches long. Five of these bars were piled and rolled down to another slab, and these two slabs were welded and rolled down to a plate 1 inch thick, which was sheared to 4 feet square. Four of such plates were then piled and rolled down into one plate, measuring 8 feet by 4 feet and 2 inches thick. Lastly, four of these were piled and rolled to form the final and entire plate. There were thus welded together sixteen thicknesses of plate, each of which was originally 1½ inches thick to form one plate 4½ inches thick. In this operation from 3,500 to 4,000 square feet of surface had to be perfectly welded by the process of rolling."

The increase in the caliber of guns, and to some extent the use of steel shot, soon brought about an increase in the thickness of wrought-iron armor. Thus we find experiments against 5½-inch, 6½-inch and 7½-inch iron plates in March, 1863, with guns of varying diameter of bore up to 10 inches, while the side armor of the "Bellerophon" (1866) was increased to 5¾ inches in thickness. Another important factor in this connection was the introduction of Palliser's ogive hardened chilled iron shot, which was first tried at Shoeburyness in November, 1863, and afterward, with slight modification in form generally adopted for use in armor trials. Against these improvements in attack, the iron manufacturer could, at the time, only reply by increasing the thickness of his armor. This is exemplified by the following table, showing the maximum thickness of armor in later ships down to the period of the construction of the "Inflexible:"

	Thickness of Side Armor. Inches.		Thickness of Side Armor. Inches.
1868 "Agincourt"....	5½	1877 "Thunderer"...	12
1870 "Repulse".....	6	1878 "Belleisle"......	12
1872 "Swiftsure"...	8	1881 "Inflexible"....	24
1874 "Rupert".....	11	(in two thicknesses of 12 inches.)	

In each case I have given the date of the completion of the vessel. In the meantime, however, important experiments were being carried on in connection with the use of steel for armor plates. The Spezzia trials of 1876 proved that the resisting power of steel was far greater than that of iron, although the plate itself was broken up in the act of repelling the attack, which was, in this trial unduly severe. The manufacture of steel in large masses was, however, in its infancy; the metal was wanting in toughness, and could not stand up to the racking effect of heavy projectiles.

Other interesting proposals were made and adopted at this period in connection with the use of steel. A notable case is that of the "Polyphemus," in which compound steel plates in two layers, were fitted by Sir Joseph Whitworth & Co., in the years 1879 to 1881, the inner layer being composed of steel plates of considerable area, with a tensile strength of 45 tons per square inch, the outer layer being formed of small steel plates about 10 inches square, having a tensile strength of 60 tons per square inch, all the plates being oil-hardened.

The introduction of compound armor about the same period, however, effected a revolution in ship protection. In the "Inflexible," the highest point, so far as iron protection was concerned, had been reached, and to meet the increasing power of the attack it had been found expedient to increase the thickness of side protection as above stated to 24 inches, with the result that only the vital parts of the vessel were protected at all. The design was much discussed at the time in papers read before the Institution, and, curiously enough, it was during its construction that the new type of armor came to the front, and its quality was sufficiently proved to justify its adoption in the turrets of the same ship. The two Sheffield firms, Brown & Cammell, working on independent lines, conceived the idea of a steel face, welded to an iron back, the object being to break up the point of the shell by means of a hard steel face, and to hold the plate together by the tough iron back. The modes of manufacture were different in detail, the Wilson plate being made by casting a steel face on to the top of a rolled iron back; while Mr. J. D. Ellis made a comparatively thin rolled-steel plate for the front of the target, and cast steel between it and

*Paper read at the Jubilee Meeting of the Institution of Naval Architects.

† It was subsequently proved at Shoeburyness, conclusively, in 1877, that a solid plate of 17-inch to 17.5-inch was equivalent, so so far as resistance was concerned, to three plates of 6.5 inch each.

the iron back. In each case the plate was subject to heavy rolling after the casting was completed. Various proportions of steel and iron were tried, and in the result a proportion of about one to two was found to give the best results. The increase in resistance afforded by this type of armor was soon recognized in Great Britian, and its partial adoption for the turret protection of the "Inflexible" effected a saving of 600 tons in weight.

Speaking generally, the superiority of compound armor over iron was computed to be in the proportion of three to two, and it was generally adopted in the British Navy for a long period. Orders were given for all the armor for the celebrated "Admiral" class to be of the compound quality, together with a number of armored cruisers, which were completed about the same time—1882 to 1889. On the Continent, the superiority of the compound plate was not so universally acknowledged, and in France the battleships building during this period were protected by steel and combined armor in about equal proportions.

Considerable improvements had been made by M. Schneider in the manufacture of solid steel plates, and for a long period of years this eminent firm competed, with varying success, with the compound armor makers. Numerous international trials were held, of which the following were the most important: (a) Spezzia, 1882; (b) Ochta, 1882; (c) Copenhagen, 1884; (d) Spezzia, 1884; (e) Pola, 1885; (f) Annapolis, 1890; (g) Ochta, 1890. It is not within the scope of this paper to give the result of these trials, but from an examination of the various reports it would appear that in b, c, e the superiority lay with the compound armor, and in a, d, f, g with the all-steel plate. In the case of the Annapolis trial, the superiority lay with a plate containing a considerable portion of nickel. The Ochta trial of 1890 introduced another firm of manufacturers of steel plates. Messrs. Vickers had produced an excellent solid steel armor-plate in the year 1888, which was tested on the "Nettle," and this class of armor was adopted for use, to some extent, at a later date by the British Admiralty.

M. Barba, the chief engineer of the Creusot Works, in a paper read before the Institution of Naval Architects, in March, 1891, strenuously argued in favor of the all-steel plate, but in the discussion that followed the preference generally appeared to be given to the compound plate. In the First Lord's Memorandum of the same year, explanatory of the Navy Estimates, it was expressly stated that for the main defence of first-class battleships compound armor was to be preferred, but that steel armor had been adopted for the secondary defence of battleships, for the protection of auxiliary armaments, and for the protection of machinery in vessels of the cruiser classes. In accordance with this decision, the main defense of the "Royal Sovereign" class and other vessels built at this period, consisted of compound armor, while the secondary armament of these ships was protected by 4 inches of steel. The greatest thickness of compound armor fitted to British ships was 20 inches, tapering to 16 inches. I refer to the "Nile" and "Trafalgar," two powerful vessels carrying four 67-ton breech-loading guns.

Numerous experiments were, however, being made by all armor manufacturers, both with compound, steel, and nickel-steel plates, in order to improve their quality. Various processes of hardening were tried—air, steam, water, lead, and oil, all with more or less encouraging results. The earliest case I can find of water-hardening on one side only of the plate appears in the records of the eminent firm of Fried. Krupp, in 1885, in connection with a compound experimental plate (one-third crucible steel and two-thirds mild Siemens-Martin steel). This was followed by other plates, treated in the same way, the water impinging on the face by the force of gravity only; but, as the firm were not makers of armor for ship protection at the time, the idea was not carried out beyond the experimental stage.

In England, the attention of Capt. Tessider was drawn to the importance of making the face of the plate so hard as to break up the point of the projectile before it had time to effect any serious penetration. The particular process he adopted was the application of a cold douche of water, under sufficient pressure, and of sufficient volume, to prevent any envelope of steam forming on the face of the plate, and thus insuring a rapid face chilling of consequent hardness. Various compound plates were tested, treated in this manner, and the object was attained. The best forged-steel armor piercing projectiles were broken up by the hardened face, and a considerable increase of resisting power was obtained.

In October, 1891, however, a plate was being tested in America which was the precursor of a complete change in armor manufacture. Mr. Harvey had obtained considerable success in applying water-hardening to cemented steel, in the construction of small articles, and conceived the idea of the manufacture of armor-plates in the same conditions. The process was, shortly, as follows: A solid-steel armor-plate was pressed and rolled, and highly cemented on the face; it was then subjected to a severe water-hardening process, somewhat similar in the later plates to that above referred to. The resultant was a glass-hard face, with a mild-steel back, and subsequent trials in various parts of the world secured its nearly universal adoption. The resisting power of armor was raised by 50 per cent. Sir William White, in a speech made at the meeting of the Institution of Naval Architects in 1894, put the superiority even higher, referring to experiments which showed that as far as resistance was concerned, 6 inches of Harveyed steel was equal to 10 inches of compound armor. This being so, naturally we find in the battleships of this period a corresponding diminution in thickness of the plates utilized for ship protection; thus in the well-known "Majestic" class (1895-1897) the thickness of side armor was reduced to 9 inches, advantage being taken of the saving in weight effected by the new armor for a given resistance by fitting two tiers of the thickness above mentioned on the belt of the vessel, and greatly increasing the length so protected.

The best American results had been obtained with Harveyed nickel steel, but the value of the nickel alloy was not sufficiently proved by the later experiments as to make its adoption universal. The Harvey plate, however, with all its merits, had one defect; the back was not sufficiently tough to withstand the racking effect of steel projectiles. It is due to the genius of the experts of the firm of Fried. Krupp that a most valuable improvement was effected in this connection. After various experiments with different alloys of mild steel, chrome steel and nickel-chrome steel, the first properly so-called Krupp plate was made in the year 1894, and on trial gave excellent results. In this plate, which was in nickel-chrome alloy, for the first time the principle of differential treatment in the final processes of hardening was adopted. A special heating-furnace was built, and the temperature of the face of the plate was raised to a certain depth, sufficiently to allow of the highest degree of hardness being obtained. The remainder of the plate was only heated sufficiently to insure toughness and a fibrous structure when hardened by water. The hardening was then effected by spraying under pressure the front and back of the plate simultaneously until completely cooled.

In the following year the results obtained by this mode of treatment were repeatedly confirmed, and the invention became a practical success. The crystalline structure of the back of the Harvey plate was replaced by a tough fibrous quality, which prevented cracking, and, by spreading the resistance to the impact of the projectile over a wider area, assisted materially in reduction of penetration. Trials of similar plates made by British makers followed with similar results, and this class of armor was soon afterwards universally adopted in the service.

In the year 1894 it was my privilege to be allowed to give to the Institution the results of trials of Harveyed armor, and it will be of interest to give a few instances of trials of the more modern type, without going into detail, but giving particulars sufficient to show the advance that had been obtained in ship protection. In 1899 a trial of a Krupp plate 5.9 inches in thickness took place. Six shots (Wheeler-Stirling armor-piercing projectiles) were fired at striking velocities ranging from 1928 to 2211 foot-seconds. In each case the projectile was completely broken up, the greatest penetration did not exceed 5 inches and the plate was practically free from cracks, a slight opening only be observable in the bulge at the back in the case of one of the shots. The behavior of a plate 8 feet square by 8.8 inches in thickness was practically similar when attacked by an 8-inch armor-piercing projectile with velocities of 1,854, 1,964, and 2,039 foot seconds, respectively. I give a further instance of a plate 12 inches thick tested in 1897. The plate, which measured 10 feet by 7 feet, was attacked by three armor-piercing projectiles of high quality, weighing 720 pounds each, at velocities of 1,860, 1,861, and 1,868 foot-seconds. In each case the projectile was completely broken up, no cracks appeared in the plate, and the greatest penetration was computed to be 2.75 inches.

The instances above given are put forward as being fairly representative, and not selected as showing the highest point of efficiency this type of armor has reached. They are however, sufficient to show the great characteristics of the Krupp plate; resistance to perforation and practical freedom from cracking. In each case the plate could have stood considerably more punishment. Summing up the results, it would appear that the relative thickness of wrought iron to give equal resistance to the attack would be, according to the recognized formula, from 230 to 280 per cent of the thickness of the plate tried, and it must be remembered that in no case was the plate tested to the point of complete perforation.

The superiority of the Krupp type of armor has been long acknowledged. It must not, however, be assumed that finality has been reached. It may well be that, particularly in connection with capped projectiles of large diameters, as compared with the thickness of armor attacked, improvements will be made, and this Institution may rest assured that armor-plate manufacturers are very desirous of taking advantage of any invention of practical utility which may be brought to their notice, or which may be discovered in their own research laboratories. Consideration of these matters may, however, be left to the future.

I feel, in conclusion, that I have only touched on the fringe of this great question. Had it been possible, I should have liked to refer in detail to the excellent work which has been done by the various firms individually in connection with the manufacture of armor, and to have noted the great success which the newest of the armor-making countries, Japan, has achieved in supplies to war vessels, both battleships and cruisers. I should have liked also to have referred to the important question of power of production in the various armor-making countries of the world. These are facts, however, well known to many of the foreign guests of the Institution. It is sufficient to say that the world supply appears more than equal to the world demand, and, speaking in the name of armor-makers generally, I am confident that any increased requirements will be readily met, whether in quantity or quality. At any rate, no effort has been or will be spared to give to the navies of the world the best protection that can be devised. Many papers have been read at this meeting illustrating the great advance which has been made during the past fifty years in various branches of naval architecture and marine engineering. I trust that the remarks I have had the honor to make may be sufficient to show that, in the manufacture of armor for ships during the same period, satisfactory progress has been achieved, commensurate with the great importance of the subject.—*Engineering.*

Musical Insects

A UNIQUE expression of the love of nature everywhere to be observed among the Japanese is the keeping of so-called musical insects, in whose song (if we may so call it) they take the same pleasure as in that of birds, paying the little creatures in their tiny cages the greatest care in order to prolong their life which at best lasts but a few weeks.

In the city of Tokio there are two wholesale dealers in the various popular insects and during the summer and early autumn some sixty street venders conduct a profitable business by peddling musical insects, the prices of which range from 5 to 15 sen ($2\frac{1}{2}$ to $7\frac{1}{2}$ cents) and also the cages in which the insects are confined, very small affairs, usually made of bamboo, and sometimes quite elaborate. These men often clear as much as 1 yen 80 sen (about 89 cents) per day when business is brisk, but on the other hand often lose much of their profit by the death of their delicate prisoners.

There are several kinds of insects offered for sale, among which are the calytotryphus marmoratus, homoeogryllus Japanicus, grasshopper, noisy cricket, common cricket and kusa hibari, the last named and the grasshopper being the highest priced when healthy and first class singers. Most of these insects are reared in much the same fashion as silk-worms and require all the attention that these do. In the case of grasshoppers, the females are taken from the fields during the latter part of September, just before the laying season, and placed in glass receptacles, in which a portion of red earth has been placed. Upon this the eggs are deposited, after which the female dies. The eggs must be kept at a temperature not below 80 deg. Cent., until the time for hatching, which is about the end of March. Each female produces about 100 eggs, of which half are females, 10 per cent of which die. The young insects are fed on food consisting of vegetables, wheat and small quantities of river-fish, well mixed together and finely ground. The homoeogryllus Japanicus requires a somewhat different treatment. Both males and females are captured and confined in pairs in bottles in which a little crude sugar is placed. The insects die after the eggs are laid, and the latter must be kept in a warm place until springtime, when they hatch. The sugar in the bottle affords a substitute for the honey the young insects would normally obtain for food. The life of insects reared in this manner is naturally shorter than that of those in the free state, but lasts at least 4 to 5 weeks. They are best kept in a dark place during the day, and for this reason the venders are mostly seen on the streets at night. The peculiar notes made by these insects are difficult to describe. A musical insect not on the market, because it exists everywhere by the thousands, is the locust (*cicada*). Children catch them by means of a bamboo pole, on the ends of which birdlime has been smeared, and often cage them, though their singing may be heard all day, and sometimes long after sunset, from every bush and tree. It is the male insect which produces the peculiar noise, sometimes approaching musical sounds, by means of organs situated on the underside of the body, consisting of stretched membranes, acted upon by powerful muscles.—*Japan Magazine (condensed).*

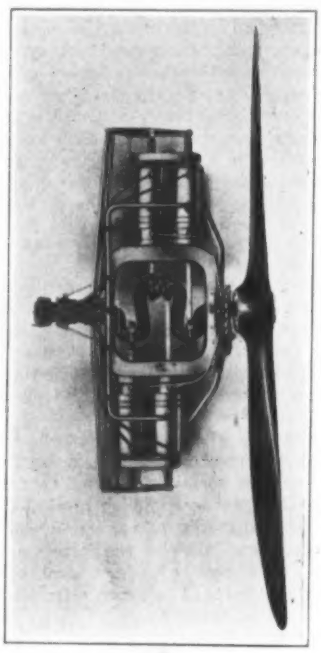
Dynamos for Telegraph Service.—We read in *Le Génie Civil* that the use of dynamos instead of cells or storage batteries has been introduced with much success for telegraph service at Marseilles, in France. Three different tensions are employed. The installation works with complete satisfaction and the economies gained are such as to repay the first cost within one year.

New Aeroplane Motors at the Paris Show

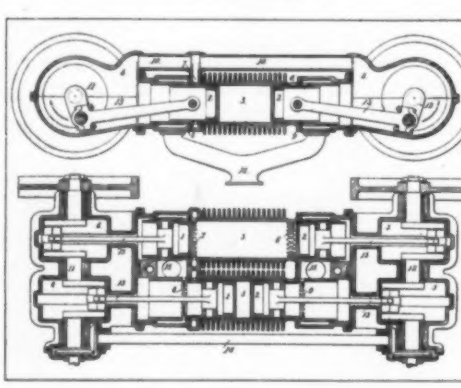
A Description of the Principal Types Exhibited

By the Paris Correspondent of the Scientific American

The Oerlikon Motor.—The new model brought out by the Oerlikon Machine Works of Zurich presents several original features. While the weight of the motor has been forced down to a minimum, this has been achieved by approved means, and the entire structure is thoroughly solid. An aluminium frame carries the four cylinders and the shaft bearings. The cylinders are of nickel steel and are attached to the aluminium frame. The crank shaft has three cranks placed at 120 degrees and runs in strong ball bearings carried in the frame. The present design gives a thoroughly well balanced motor and thus insures perfectly smooth running. As a matter of fact, the balancing is better than that obtained with a four-cylinder vertical motor and is equal to that of a six-cylinder. The cylinders are made of forged steel with copper water jackets. One of the new features of particular interest is the use of a single valve of special design for intake and discharge. The aluminium mounting of the valve is hollow and connects with the carbureter. The valve is designed after the usual pattern, except that it carries a small piston slide-valve upon the rod. During the two periods of compression and expansion the valve rests upon its seat; but at the moment of discharge it is lifted and allows the waste gases to escape. At this instant the slide valve shuts off the inlet openings. Then at the moment of intake the valve lifts up higher, carrying with it the slide valve which now uncovers the intake openings and covers the annular space which establishes connection with the outer air, so that gas enters the cylinder. The gases escape freely and directly to the air, and the valve, whose rod is in connection with the air for three periods out of four, is cooled by the fresh gas during the fourth period. The spring is remote from the heated parts and is therefore protected from the influence of high temperatures. The crank rod is not connected to the piston by a pin but through a ball bearing, the rod carrying ball bearings both at the top and bottom. This is quite an advantage, as it is generally admitted that there is difficulty in keeping the crank pin well oiled and that it is very apt to become heated. The use of ball bearings here as well as in the main bearings greatly simplifies lubrication, so that the motor requires only about one-eighth of a gallon of oil per hour. The crank shaft is of a new design and is made of forged nickel steel, in the form of a curved tube of nearly uniform section throughout. This shape is found to be advantageous in every way and furthermore permits the use of small-diameter ball bearings for the crank shafts. Valve movement is effected by two long rods on each side of the motor, working by cams which run at one-half the motor speed. The carbureters are mounted directly under the valve heads, so that they are kept heated, and gas is produced regularly even in very cold weather. Any formation of frost on the carbureters is prevented. Ignition is effected by a magneto running at the same speed as the motor. The new Oerlikon model is built in 50 to 60 horse-power size. The cylinders measure 4 inches in diameter and 8 inches in stroke, and are run at 1,000 to 1,200 revolutions per minute. The weight, inclusive of magneto, carbureters and water pump, is 175 pounds; in full working trim with propeller and radiator attached, the motor weighs 240 pounds.



Oerlikon Motor.

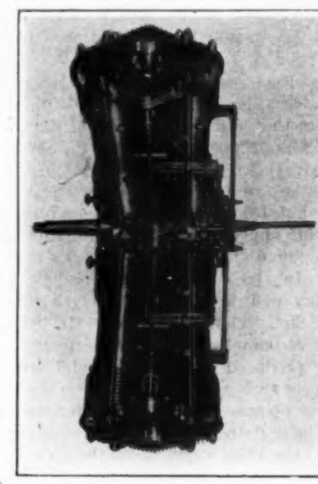


Section Through the Messpa Motor.

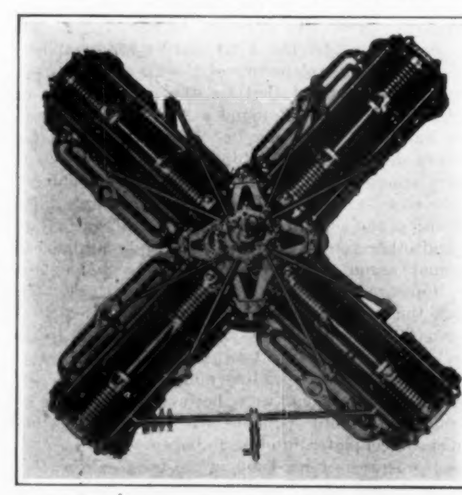
Two Propeller Messpa Motor.

The Messpa Motor.—This model is of the two-cycle type and has two cylinders arranged side by side. Good balancing is secured by the use of a double piston with each cylinder. Each pair of pistons works upon one crank shaft at the end of the motor, and one propeller is carried on each of these shafts, the motor being designed to work with a double propeller. The gas distribution is effected entirely by pistons, there being no special moving parts provided for this purpose. When the pistons stand at the extreme inner position, the gas from the carbureter enters by ports 8 and 9 (see drawing) and the pistons compress the gas somewhat. As the pistons move toward their extreme outer position, the gas enters the cylinder through the pipe 10 and port 7, driving before them the waste gases which escapes by the openings 6. After this the gas is compressed, ignited and expanded in the usual way. This method of distribution without any kind of valves is found to work very reliably with all speeds of the motor and there is no danger of failures, so that the speed can easily be run up to 2,000 revolutions per minute with one explosion per revolution in each cylinder. The motor exhibited at this show is one of the first built by the inventor and is designed for 80 horse-power when working at the speed mentioned above. The use of a special patent carbureter, which functions at the same time as the speed regulator, gives an extended working range, so that the speed can be varied from 600 to 2,000 revolutions per minute. When in use on the aeroplane the motor is never actually stopped, but only slowed down at landing.

The Favata Motor.—Another of the exhibits shown in our illustrations is the Favata motor, military type, which with a horse-power of 180 weighs only 350 pounds. It is made up of four elementary groups, disposed around the common crank shaft. Each group is composed of two cylinder bodies, placed parallel to each other. These cylinders are in reality double, having a separate central and a peripheral working portion. The central part of each cylinder doublet has two long openings on opposite faces, to allow the passage of the crank pin. Each doublet comprises two short pistons built in one piece with the central rod, the crank shaft being connected to the middle of this rod, so that the two pairs of pistons work together upon a single crank rod. At each end of the doublet is a hollow cap or end plate, which is common to two cylinders, so that

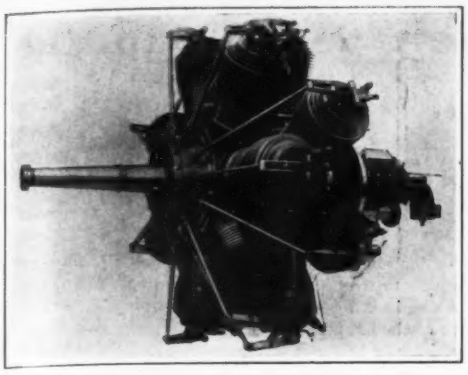


Favata "Military" Type 180-horse-power.



The 180-horse-power Favata. "Military" Type.

Detail of the 180-horse-power Favata.



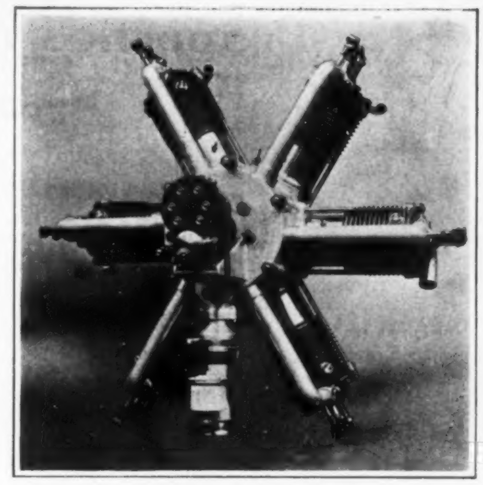
The 140-horse-power Gnome Motor.

these work with a common explosion cylinder. The end caps are especially designed to act as cooling wings. The caps on the inner end of the cylinder are joined together and practically make up the crank case. Although there is but one explosion chamber at each end, the cap is provided with two spark plugs corresponding to the two cylinders. The caps are held in place by draw bolts or rods. There are only two valves in each cap placed on opposite sides and the corresponding intake and discharge valves on one side are connected to a common rod, driven by a single mechanism, so that the entire construction is much simplified. Thus a single group such as has just been described contains but two cylinder heads instead of four, and only four valves instead of eight, as usual, and there is only a single crank rod and crank. Each group gives one explosive impulse on the main shaft per revolution, owing to the arrangement of the cylinders.

The Gnome Motor.—Motors of the rotary type, that is to say, motors in which the crank is stationary and the pistons revolve around the shaft, are in very general use on French aeroplanes. The advantages of this system are well known to our readers. On the one hand the *ensemble* of pistons forms a very efficient flywheel, which secures regular running and contributes greatly to the preservation of the propeller. On the other hand, as the pistons are rapidly whirled through the air, very efficient cooling is thus automatically provided.

The best known of the rotary motors is the Gnome. Among the exhibits of this make is the 50 horse-power Omega type, which has seven cylinders provided with cooling wings. In this model the shaft supporting the motor and carrying the main thrust bearings is made hollow, the gas and the pipes for the lubricating oil passing through it. The inlet valves are automatic and are balanced by a system of counterweights so that they cannot be disturbed by centrifugal action when the motor is running. At the rear is a box containing the main and thrust ball bearings and in front is a corresponding box with the shaft ball bearings and the cam gearing, and also the seven cams from which the rods pass out of the cylinder heads. These two boxes form part of the crank case. At the cylinder end of each radial unit is the automatic inlet valve shown at *s* in the accompanying line drawing, and the cam-driven exhaust valve *h*. The speed of the 50 horse-power motor can be varied from 200 to 1,300 revolutions per minute. The consumption of gasoline is 270 grams per horse-power hour, and that of lubricating oil three-fourths of a gallon per hour. There is also made a 70 horse-power motor, which also has seven cylinders but is of heavier build all round. It runs from 800 to 1,300 revolutions per minute and uses 1.3 gallons of lubricating oil per hour. Double motors are also built for 100 and 140 horse-power. The latter is of recent construction and is a good example of the progress which is being made in high power aeroplane motors.

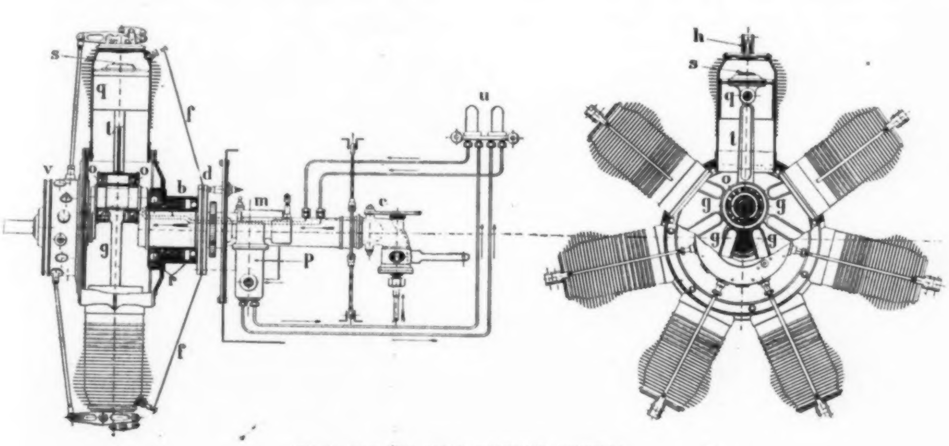
The Anzani Motor.—We illustrate two of the more recent Anzani motors. One of these, shown mounted upon an aeroplane, is the smaller, three-cylinder type. This is a thoroughly well balanced motor, remarkable for its light weight. The three cylinders are equally spaced around the crank case, and the valves are cam



Six-cylinder 50-horse-power Anzani.

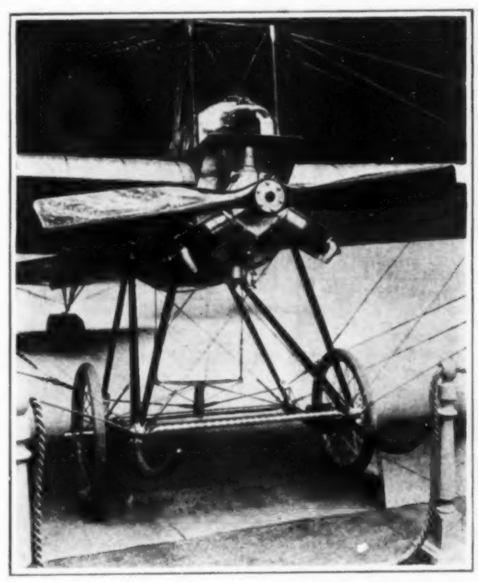
driven. In all the new Anzani motors the cylinders are entirely air cooled, and the inventor has been very successful in designing motors along this line. Owing to the fact that the motor runs very regularly it is possible to dispense with the flywheel. The motor shown can be run up to 40 horse-power, and, together with the magneto, weighs but 120 pounds. Owing to its flat shape it is well adapted for mounting at the front of the aeroplane.

There is also a large 1912 model, with six cylinders and 50 to 60 horse-power. It is built on the same general principles as the above, and weighs 160 pounds. A number of Anzani motors of the two types here described are in use in the French army.



DETAILS OF THE GNOME MOTOR.

c, carbureter; *p*, oil pump; *m*, magneto; *ff*, ignition wires; *d*, current distributer; *b*, front box; *r*, shaft ball bearings; *v*, distributing box; *q*, piston; *s*, intake valve; *h*, discharge valve; *t*, piston rod; *g*, connecting rods; *o*, piston rod ball bearings; *u*, oil cups.



Three-cylinder Anzani.

Color Photography on Utocolor Paper*

By G. LE MARESCHAL.

THE problem of color photography as solved at the present time by the auto-chrome and other plates, in spite of the beauty of the colors obtained, does not give entire satisfaction because it is limited to the production of one single image, which incidentally can be viewed only by transmitted light or by projection upon a screen. The complete solution of the problem would demand that just as in ordinary black and white photography, the negative primarily obtained should be capable of yielding an unlimited number of copies by simple exposure to the light in a printing frame. The researches made in this direction date from a good many years ago. As early as 1881 C. H. Cros endeavored to draw advantage from the commonly observed fact that colors fade when exposed to daylight. We are all familiar with the appearance presented by a wall paper which has been in use for a number of years and from which the pictures adorning the walls are removed. The space formerly occupied by pictures and similar articles show up in bright color, whereas the rest of the paper is faded. Cros, however, went further than this and drew attention to the fact that the effect produced by an opaque article is equally well secured by covering the tinted material with a transparent glass of the same color as the material to be protected from the light. Certain aniline colors show this effect in a particularly high degree.

If a properly selected set of three fundamental colors, red, blue and yellow, are spread over a piece of paper, a practically black surface is obtained. If this is now exposed to the sun behind a colored glass, those colors which are transmitted by the glass are bleached out and there is left an image having the same color as the transparent glass. It will easily be seen that this property may be made use of to copy colored photographs. Needless to say, the actual technical exploitation of this invention required the solution of a large number of subsidiary problems, but finally success was attained. A number of workers have contributed their share toward the solution of the problem, among them Wiener, Vallot, Lumiere, etc. The most important discovery made in the course of the investigation was the finding of so-called sensitizers, which greatly accelerate the otherwise slow bleaching effect. After the exposure is completed, the sensitizer is eliminated by washing, so that the remaining picture is fairly permanent. (As a matter of fact, it has to be preserved in shelter from light; for instance, in a photograph album.) The sensitizer employed is anethol, and the fixing solution to dissolve it out of the paper is benzine.

The final result of these researches is a paper placed on the market under the name of Utocolor paper, which is manufactured in the neighborhood of Paris. The use of this paper is just as simple as that of any other photographic copying paper. An auto-chrome plate is laid in the printing frame, and over it, in contact with the gelatine, the utocolor paper, which is then exposed to the light. The process is watched by now and again opening the frame and inspecting the image. When the printing has proceeded sufficiently far, the image is fixed in two special baths and is then allowed to dry.

In practice there are one or two little points which require attention. The paper is slightly sticky, especially in moist weather, and the makers recommend that the auto-chrome plate be covered with a varnish which they supply for this express purpose. A better way is to place a thin celluloid film between the plate and the paper.

The exposure is unfortunately very long—a number of hours in strong sunlight or a number of days in subdued light. If sunlight is used it is found necessary to use a green screen, otherwise the image shows an undue preponderance of red. The colors of the copy appear somewhat duller than those of the original, and the right and left hand relation are of course inverted. In many cases this may not be thought a serious drawback. In others, however, it is a more or less complete bar to the use of the process. There should, however, be no difficulty in modifying the process in such manner as to enable the picture to be reversed in somewhat the same way as carbon prints are reversed in the regular procedure followed in their application. The inventor is at present working out the details of this step.

To give full artistic satisfaction the process must yet undergo some further improvement. It does, at the present time, however, give most interesting results and its future development will be watched by all with much interest.

* Abridged translation from *La Nature*.

The Properties of Selenium and Their Applications to Electrotechnics—III.

By Erich Hausmann, Sc.D.

Concluded from Supplement No. 1882, page 51.

Practical Applications of the Electrical Property of Selenium.

Wireless Telephony.

Not long after Willoughby Smith's discovery, various experimentors sought practical applications of the property possessed by selenium of varying its electrical resistance under the influence of light. Among the first of these was Alexander Graham Bell, who, some twenty-seven years ago, made interesting experiments with his radiophone, a diagram of which is shown in Fig. 10, for the transmission of speech.

In this arrangement, a mica or glass diaphragm, *d*, with a silver coating reflects a powerful beam of light upon a selenium cell from some luminous sources, placed at the focus of a parabolic reflector, the cell being connected to a telephone receiver and battery. Words spoken into the mouthpiece behind the diaphragm set the latter in vibration and causes pulsations in the reflected light upon the selenium cell *C*, thus producing corresponding variations in its resistance and reproducing audible sounds in the telephone receiver *R*. This device was only used for transmitting speech over comparatively short distances (213 meters).

Variations in intensity of the beam of light, which correspond to particular sound waves, may be produced in several ways. The best method employs the "speaking arc" which, when placed at the focus of a parabolic mirror would constitute the sending station of a wireless telephone system. An arc lamp, whose circuit is coupled with a telephone circuit, may be caused to emit sounds similar to those spoken into the transmitter of the telephone; and when used in this way is termed a speaking arc.

The most successful experiments which have been made with the speaking arc in conjunction with selenium cells are those of Ruhmer. The arrangement of one of his sending stations for the transmission of speech over a distance of five miles is shown in Fig. 11.

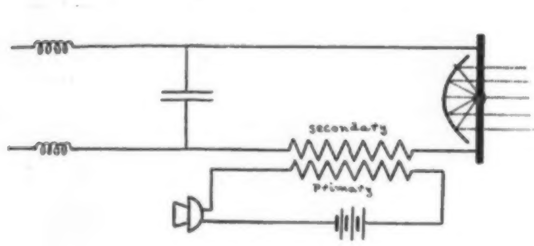


Fig. 11.

An arc lamp with a flaring arc 1 centimeter long is connected to a 220-volt circuit through two choke coils; the coils preventing the high-frequency currents produced by the voice from entering the line. This alternating current flows from the secondary winding of the induction coil through the condenser and arc and returns. A carbon transmitter, in circuit with the primary winding and battery, superimposes waves, identical with the sound waves incident on the transmitter diaphragm, on the arc light circuit. The beam of light is reflected to some distant point, where it is received by a parabolic reflector, in the focus of which is placed a selenium cell, connected to a battery and sensitive telephone receiver. In the receiver are heard sounds similar to those at the sending station, this being accomplished by the variations of resistance of the selenium cell changing the intensity of the current flowing in the circuit. This investigator has conducted extensive experiments, both by night and by day, and in fog and rain, on the Wannsee, near Berlin, with remarkable success. With a large searchlight at the sending station he was able to transmit speech over a distance of 15 miles.

Operating Local Circuits.

There are many interesting applications of the selenium cell for demonstrative purposes in conjunction with a relay and battery, such as, starting and stopping a motor, ringing a bell, lighting lamps, firing a cannon, etc., at a distance. In 1890, Bidwell suggested the protection of safes by using selenium cells; these being actuated by the light from a burglar's lantern, thus giving an alarm.

An important practical application of the selenium cell introduced by Ruhmer, is the electrically controlled buoy; some of these operate successfully near Hamburg and in the Baltic Sea. A selenium cell is placed in the top of a buoy containing compressed gas, together with a switching device, battery and relay. When the sun rises in the morning, the resistance of the cell is lowered thereby causing the gas to be turned off; the gas being again turned on upon the increase of the resistance of the selenium cell upon the approach of darkness. The

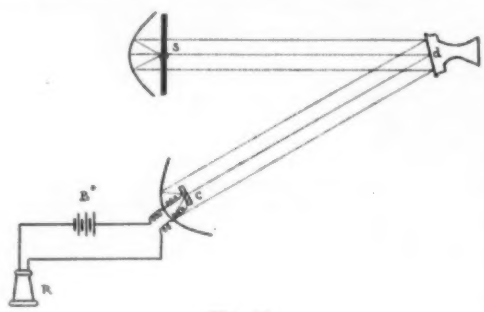


Fig. 10.

amount of gas consumed for illuminated buoys is reduced by such an arrangement.

Photometry.

In the discussion following Willoughby Smith's announcement that the resistance of selenium depends upon the incident light, Latimer Clark suggested the use of selenium for photometric purposes. A number of investigators have given attention to this possible application since that time; their endeavors being also directed toward solving the color problem in photometry. This difficulty has not yet been overcome, and it is very doubtful if the use of selenium will offer a solution; since its sensibility varies greatly for lights of different wave lengths, as seen in Fig. 4. Even in comparing lights of the same color, the difficulties with selenium for photometric use are many. Among these may be mentioned: 1, resistance variation in course of time; 2, effect of duration of exposure; 3, effect of the intensity of current flowing; 4, effect of heat developed; and 5, the slow recovery of original resistance after exposure. Many photometers have been designed in which some of those troubles have been eliminated.

An accurate selenium photometer of recent design, constructed by the Elektromechanische Werkstätte of Mainz, deserves attention. Its principal characteristic is an arrangement whereby the selenium cell is alternately illuminated by the standard lamp and by the lamp under test, this result being obtained by giving the cell a reciprocating movement, causing it to pass directly from one illumination to the other. A view of the general arrangement is given in Fig. 12.

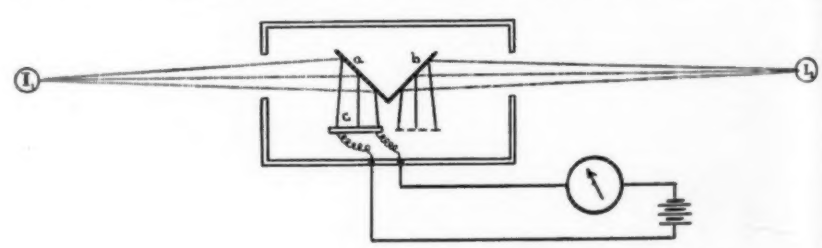


Fig. 12.

I_1 and I_2 are the two sources of light which are placed upon the photometer bench; *a* and *b* are two mirrors, reflecting the light so that the oscillating selenium cell *c* is successively illuminated by the two lamps. The electrical circuit consists of a milliammeter and battery in series with the cell. When the two illuminations are equal the current in the circuit becomes constant and the pointer of the meter remains stationary. If the two illuminations are unequal, the pointer vibrates in proportion to the difference of illumination. A balance can be obtained by shifting either the photometer box or one of the lamps. It is claimed by the makers that this photometer is about ten times as sensitive as the usual photometric apparatus, the readings of which are vitiated by the personal error.

The Photographophone.

The photographophone is an apparatus for the reproduction of speech and music, this term being given by Ruhmer to his arrangement employing a selenium cell. This apparatus consists of a celluloid film, such as employed in moving-picture machines, which is driven at high speed by an electric motor. The box containing this film is provided with a lens and a slit, so that the rays of light from an arc lamp placed before it will fall in sharp white lines upon the moving sensitive film. The general arrangement of apparatus and circuits is shown in Fig. 13. Words spoken into the transmitter superimpose the current variations in the telephone circuit upon the current flowing in the circuit of the arc light, and cause a corresponding variation in the light thereof. After a record has been made, the film is removed and developed; it then shows a series of perpendicular striations which is really a photograph of the particular sounds spoken into the transmitter. A sound of high pitch yields fine striations very close together, whereas a sound of low pitch gives broad striations farther apart.

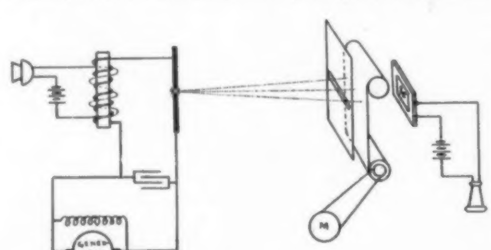


Fig. 13.

To reproduce the initial sounds, the developed film is placed in position and the motor started. The rays from the arc light, which now burns steadily, pass through the film and intermittently impinge upon a selenium cell. As the striations are of variable width and frequency, the light incident upon the cell will vary accordingly, producing a variation in its resistance. The telephone receiver connected (with a battery) to the selenium cell will therefore reproduce the sounds originally spoken into the transmitter. This apparatus will undoubtedly serve a useful purpose in light wireless telephony as a receiving instrument.

Telephotography.

The most interesting application of selenium which has excited considerable attention in scientific circles is the transmission of photographs to a distance over existing telegraph or telephone lines. Many investigators have experimented along this direction, but to Dr. Korn is due the credit for the successful transmission of pictures over great distances. His apparatus finds commercial application between the offices of the journal *Illustration* in Paris, the offices of the *Daily Mail* in London, and his own experimental station in Berlin. The best transmission is effected between Berlin and Paris, the transmission to London being poorer, due to the electrostatic capacity introduced by the Channel cable. A description of his improved apparatus, at present in use, follows:

The complete apparatus for a station consists of a transmitter and a receiver mounted together; each having a long tube through which light from the lamps at one end, passes to the rotating cylinders at the other. The principal details of the transmitter and the receiver are shown respectively in Figs. 14 and 15.

In the transmitter, the Nernst lamp, *L*, mounted within a sliding adjustable tube, sends out, through lens *A*, a beam of light which is received upon the diaphragm, g^1, after passing through lens G^1. The diaphragm serves to concentrate the light to a point upon the glass cylinder, around which is placed the photograph in the shape of a positive film; the cylinder being mounted upon the rotating shaft *V* by means of the disk *U*, thus facilitating its removal. The beam of light passes through the photographic film and is reflected upward within the cylinder by the prism *p* and impinges upon the selenium cell Se_1. The cylinder *T*, in addition

to its rotary motion has an axial movement, so that all parts of the photograph come opposite the point of light. As the cylinder revolves, the illumination on the selenium cell will change, thus sending a current of variable intensity to the receiver.

The receiver (Fig. 15) is provided with a Nernst lamp, L^1 (mounted within a sliding tube) which sends out a beam of light, traversing the galvanometer shutter *b*. This important instrument, called a light-relay, consists of an electromagnet, *d*, provided with long perforated pole pieces, *e e*, between which is placed the moving element, *J*.. This consists of a double fine platinum wire under tension, carrying a small sheet of aluminium foil, *b*. When a current flows through the wire, the electromagnet being separately excited, the aluminium sheet is deflected to one side and the amount of the deflection is proportional to the current flowing. Thus, the intensity of the beam of light which passes through the light-relay to the cylinder *D*, depends upon the current in the line. The cylinder, which is usually somewhat smaller than that of the transmitter, is mounted on a revolving shaft, *N*, by means of the disk, *M*. The shaft has also an axial movement, so that all parts of the cylinder surface are brought successively under the point of light emerging from the diaphragm. Thus, the variable current coming from the transmitter causes a corresponding variation in the amount of light incident upon the receiving cylinder, and an exact reproduction of the original photograph may be obtained upon developing the received image.

It is necessary for the proper operation of this apparatus that the inertia of the selenium cell be compensated for, so that it will respond almost immediately to the variations of light incident upon it. This compensating action is secured by the use of a second selenium cell connected with the cell of the transmitter, so that the resultant conductivity-time curve of both rises quickly at the start and falls equally quick upon darkening the cell. As the receiver of a station is not in use when sending, the light-relay of the receiver can be employed for the inertia compensator, as shown in Fig. 15. In the bottom of the vertical mirror-lined chamber is the cell, Se_2, which receives illumination from the lamp L^1 by means of the reflecting prism *I*. To secure a diffused light upon this selenium cell, a series of glass cylindrical rods is interposed at *R*. When the transmitter cell, Se_1, is illuminated, a current flows through the neighboring light-relay deflecting its shield, and thus gives the compensating cell, Se_2, a corresponding illumination. The two cells are connected in opposition, and the resulting current variation corresponds very closely with the variations of light, owing to the fact that the two cells are different in character.

The method of connecting the selenium cells is shown in Fig. 16. The cells must be selected so that they act differently when illuminated, the resistance variations being different for the same illumination. The effect of the differential current from the cell which flows between

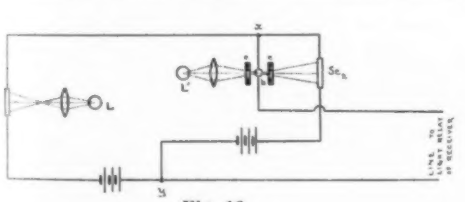


Fig. 16.

x and *y*, is shown in Fig. 17, in which the conductivity-time curve of each cell is also shown. The curve for Se_1 is placed above the datum line and that for Se_2 below, in the negative sense; the ordinates of the latter curve being smaller because of the higher resistance of this cell. The curve of current flowing through the light-relays is shown at *C*, the ordinates of this curve being the algebraic sum of those of the other two curves. As will be observed, the time of decay and the time of rise is practically identical, and the rate of change is exceedingly rapid. In photographic transmission, we have primarily to deal with the rise and fall of current, thus the long practically horizontal line is absent. As cell Se_2 is not illuminated at exactly the same instant as Se_1, its curve will begin shortly after that of the latter, as shown. The use of the compensating cell results in a considerable gain in photographic detail.

As the normal swing of the light-relay is from 0.01 to 0.02 seconds, a rapid variation of current is permissible, and the cylinder at the transmitting end can, therefore, be rotated very rapidly. At present a photograph 9 inches x 6 inches can be reproduced in 12 minutes, the size of the received image being 4 inches x 2½ inches.

It is obvious that the cylinder at the transmitting station and that at the receiving station must revolve

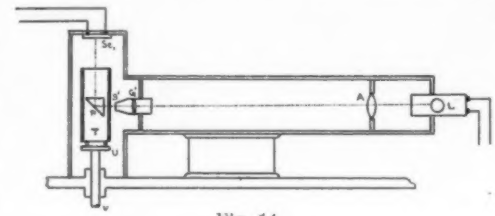


Fig. 14.

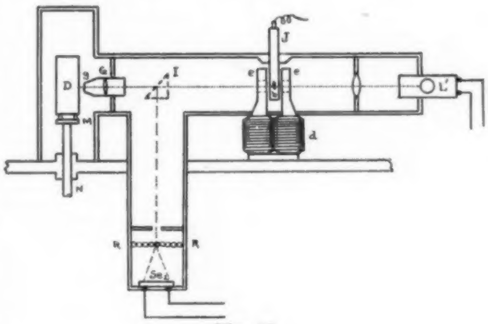
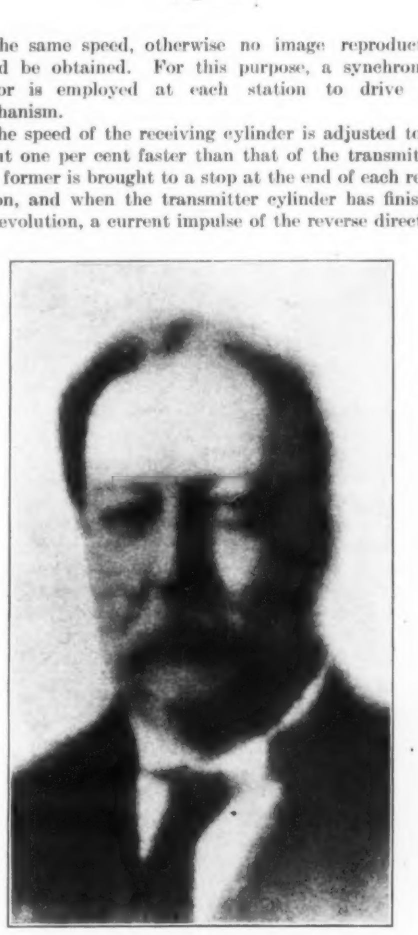


Fig. 15.

at the same speed, otherwise no image reproduction could be obtained. For this purpose, a synchronous motor is employed at each station to drive the mechanism.

The speed of the receiving cylinder is adjusted to be about one per cent faster than that of the transmitter. The former is brought to a stop at the end of each revolution, and when the transmitter cylinder has finished its revolution, a current impulse of the reverse direction



By courtesy of *Collier's Weekly*.

Fig. 18.

is sent to the receiving station actuating a relay there and releasing the cylinder. Both cylinders then start up together upon the next revolution; thus approximate synchronism is secured.

The results obtained with this apparatus may be judged from the accompanying photograph of our Chief Executive (Fig. 18) which was transmitted from Washington to New York.

TELEVISION.

A problem which has confronted physicists of late is that of seeing at a far distance. The property of selenium of changing its electrical resistance under the influence of light is usually associated with the solution of this problem. Such a solution has been proposed by Knothe.

His arrangement is indicated in Fig. 19, where the transmitting apparatus is shown at the left and the receiving apparatus at the right. In the figure, *C* is a camera, in which the usual photographic plate is replaced by a great number of small selenium cells (only four of which are shown). Each cell is in a separate circuit with a battery and induction coil, the secondary terminals of the coil leading to a large X-ray tube, which comprises the receiving station. The positive high-tension lead is common to all the induction coils and connects with the anode of the Roentgen-ray tube; whereas all the negative high-tension leads from the coils are insulated from each other and connect to successive cathode electrodes in the tube. The individual bundles of X-rays, emerging from the anode, are received upon the fluorescent screen *F* as a series of light spots. If a number of the selenium cells comprising a certain configuration be illuminated, the corresponding induction coils will be actuated, and, if the cathode electrodes constitute the same orderly arrangement on a hemi-spherical surface, as do the selenium cells on the plane surface at the transmitter, then bundles of X-rays will impinge upon the screen in the proper position so as to reproduce the given configuration. If the individual circuits be of the same length, and if the selenium cells be constructed identically the same with regard to thickness and method of crystallization, and further, if the reception plate and cathode area be large, then the apparatus will reproduce images of variable light intensity, some spots on the screen being bright and others dark. The resulting pictures on the screen consist of a number of points; to eliminate this disturbing effect, it is necessary to observe the foregoing conditions, and also to employ a great number of cells and a small fluorescent screen.

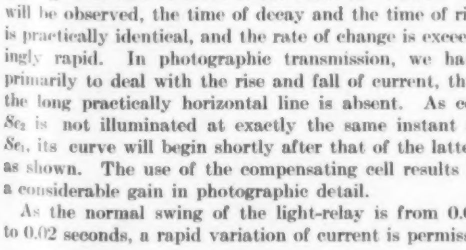


Fig. 19.

It is obvious that an apparatus such as just described must be very expensive, inasmuch as each of the many circuits must be equipped with a separate induction coil, battery, and selenium cell. Another, yet a comparatively less expensive item, is that of the cable between two such stations, it consisting of many hundreds of wires. This solution of the problem of television is highly impracticable, yet it shows that a solution exists.

Geometrical patterns have been successfully transmitted between Brussels and Liege, a distance of 72 miles, by Ruhmer. His apparatus consisted of 25 selenium cells, each about 5 centimeters square, at the transmitting station. It is likely that a much larger apparatus, based upon the same principles, will be constructed in the near future.

Rignoux and Fournier have developed a system of television, involving the employment of a multitude of cells but employing only two connecting wires between the stations. The currents from the various circuits are taken successively by a rapidly rotating arm at the transmitting station and supplied to the two line wires. The principle of the receiving device is based upon the Faraday Effect. The arrangement of the apparatus at this station is shown in Fig. 20, in which *L* is a source of light whose rays are polarized by the prism *p* and then traverse a tube *T* containing water, or better, carbon bisulphide. A second Nicol prism *p'* is so rotated about the direction of the light ray as an axis that the polarized

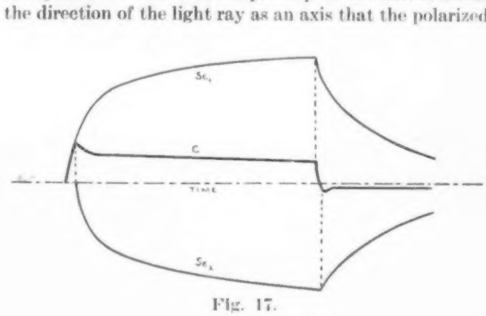


Fig. 17.

light cannot pass through, and it is fixed in this position. If a current flows through the electro-magnet *E* which surrounds the tube filled with liquid, the angle of polarization changes and the prism *p'* no longer prevents the light from passing through it. Thus, a beam of light of varying intensity, corresponding to the illumination of the particular selenium cell connected at that instant with the line wires, falls upon the cylinder *C*, which rotates in synchronism with the collector arm at the transmitting station. This cylinder carries a number of small mirrors, *M*, which are so arranged that the light reflected from each falls on a particular part of the screen *S*. On this screen is therefore formed a picture, consisting of patches of various degrees of brightness, of the object exposed at the transmitter. The different parts of the picture, although projected successively, will appear simultaneously, if the entire picture is produced within a fraction of a second. An indefinite repetition of this process yields a persistent picture.

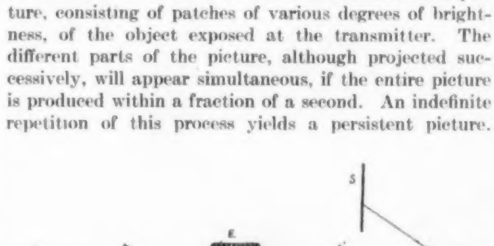


Fig. 20.

By employing a ground return, only one wire is required for this system of television.

It is worthy of note that if it were possible to reduce the time of transmitting pictures by the Korn system from twelve minutes to say, one-fifth of a second, then seeing in the distance could be attained by his apparatus, since the retention of an image on the retina of the eye lasts for this period of time. Over two hundred patents are registered in Germany alone for television employing a single selenium cell.

Engineering Notes.

The Resharpening of Tools by Electrolysis.—Under the signature M. E. Schneckenberg a study appears in *Werkstattentechnik* on the resharpening of tools by electrolysis. Several processes are given. One consists in utilizing the electromotive force produced when the metal and the electrolyte are placed in contact, and the tool is connected with a block of carbon also placed in the bath, with the aim of accelerating the superficial attack of the metal. Or again, we may pass a current of electricity from an independent source through the tool and the bath. It is in this way that the best results have been obtained. Another process permits not merely the resharpening of tools, but even the manufacture of tools from bars of crude metal. One of the electrodes then consists of a perforated plate permeable to the electrolytic action; this plate reproduces in a cavity the exact shape of the tool to be formed. Little by little the bar of metal, applied to this piece, molds itself upon it under the action of the current.

Gas Motors in Central Electric Stations.—M. Aimé Witz has just published in *Génie Civil* a special paper on the employment of gas motors in central electric stations. Here, where the steam turbine has rendered such valuable service, there is a tendency to substitute the gas motor for the former source of energy (whose industrial applications are nevertheless very recent), because of the economy of the gas engine. The conclusions of this study are especially interesting, and we are glad to cite them because of the attention merited by all of the large family of internal combustion motors. The demonstration of the services which such motors can render in the vast industry of the production of electric power, with a view to the renting of power to subscribers, shows that the place they occupy in this industry is too limited; it should and will be enlarged. The gases of furnaces and coke ovens, by-products of the industries of coke and iron, will soon put in the hands of electricians a formidable power which will allow of the distribution of the current throughout vast regions in the neighborhood of metallurgic plants and coke ovens. Such establishments are multiplying, in the north and east, in the vicinity of deposits of mineral and coal. The zone of distribution will be steadily widened and the cost of the current diminished. Black coal will spread the benefits of electricity in flat country and along the coasts just as the "white coal" (i. e., water-power) does at the foot of the Alps and the Pyrenees.

A Water Railway—Steam tugs which have so far been most generally used to haul barges are extremely wasteful devices utilizing only 25 per cent of the energy expended, while affecting the bottom and banks of canals by the unavoidable motion of the water. Towing by electrical or other locomotives or crabs on the other hand is hampered by the unloading of elevators, cranes, store-houses, etc., situated in the way of the towing cable. Interesting tests of a new tugging system invented by a German government engineer, Mr. Koss, have been recently made on the Dortmund-Ems canal. The new scheme transfers towing from the banks to the canal bed itself and claims to avoid all the drawbacks of previous systems. The Koss system uses an elastic rail laid out at the bottom of the canal, where it is moored in such a way as to be readily lifted above the water level for repair, without loosening any connection. At the same time it is secured against any excessive displacement in a horizontal direction. The tug boat travels above the rail, carrying at its bottom four rollers which are clamped around the rail. These rollers are operated from the tug-boat and by their rotation pull on the rail—very much as a towel is drawn through a mangle—thus propelling the tug. The rail is lifted 1½ to 3 feet above the bottom of the canal. This drawing along on a stationery rail in the place of the ordinary propeller action is claimed to utilize three-fourths of the energy expended. The experimental tug is operated by electricity, deriving its energy through a cable from an auxiliary boat equipped with a dynamo. This, however, is only a provisional arrangement, the scheme providing a trolley wire like those of tramways to be installed alongside the canal. Electrical operation can obviously be replaced by crude-oil motors, etc., each barge being fitted with a special brake connected with the rail.—*By our Berlin correspondent.*

Science Notes

How One Day was Lost.—As the Paris meridian of 180 degrees of longitude passes between the two groups of the Wallis and Horn islands, lying under French protectorate, there is a difference of twenty-four hours in time between the two localities. Since the adoption of the Greenwich standard, however, this difference no longer exists, and thus arose the curious circumstance that one of the island groups lost a whole day by the change.

The Phosphate Industry of Tunisia.—It is perhaps not very well known that a good part of the commercial prosperity of Tunisia is due to the discovery of phosphates in that region, mainly through the work of the late Philipp Thomas, a French scientist. Accordingly Carthage Institute has undertaken the erection of a monument which will commemorate the disinterested work of this savant in a fitting manner. A certain sum has already been raised, and a subscription list has been opened at Paris for the remainder. The monument is to be executed by the sculptor Belloc.

Hybrid Cattle.—Mr. Hagenbeck has succeeded in obtaining very good results by crossing the zebu with African cows of the N'dama breed, and he also crosses the European cow with the Asiatic zebu. The resulting hybrid animals have a fine appearance. One of them reaches a weight of 2,200 pounds and is of larger size than its parents. One good point is that such animals appear to resist the diseases which affect European stock. They can be easily fattened, and when bred from a selected cow, the milk production is found to be good.

Test for Indelible Typewriter Ribbons.—For official documents it is essential to be sure that the typewriter ink employed is permanent. In order to ascertain whether a given ribbon satisfies this condition, scrape off a little of the surface, dissolve the material in hot alcohol and stain a piece of blotting paper with the liquid. If the stain is uniformly colored, the ribbon contains aniline dye. If, on the other hand, a central stain surrounded by a colorless wet blot is formed, this is an indication that the ribbon is colored by means of indelible carbon pigment.—*Cosmos.*

The French observatories are looking forward with special interest to the eclipse of the sun which is to take place on April 17th, 1912. As the eclipse will be total or nearly so in France and Spain. The totality line as indicated by Prof. Nordmann passes quite near the French capital, but the eclipse will be total in this part of France for only two seconds. On the west coast it will be four seconds, and in Spain six seconds. At Paris the eclipse commences at 10:45 A. M. and ends at 1:35 P. M. Owing to the difference of 2.5 miles in the diameter of the moon as computed by English and French astronomers, the former claim that the eclipse will not be quite total, but annular. This point will be settled when the eclipse appears.

Mural Decorations for the Hague.—Tokyo newspapers contain glowing accounts of the mural tapestries which are now under construction in the factories of Mr. Kamashima, the celebrated weaver of Kyota, which tapestries have no equal in the whole world. The two largest will be 46 yards in length and eight yards in width and the corresponding dimensions of the smaller ones will be six yards and four yards respectively. The whole will be ready in 1913. The cost of these splendid objects is to be 80,000 yen ($39,840) and Mr. Kamashima has been obliged to erect a special workshop for their weaving. The tapestries are to be presented by the Japanese government for the mural decoration of the principal chamber in the peace-tribunal at the Hague.—*Japanese Weekly Mail.*

The Oldest Known Fossils.—In the usual terminology of geological science, the rocks older than the so-called Cambrian rocks are termed "pre-Cambrian" or "Archæic." Hitherto only one instance was known of a body found in these pre-Cambrian deposits which bore any semblance to a fossilized organism. The structure has been termed eozoon canadense, and was at one time thought to be a true fossil. This has, however, been disputed, and appears extremely improbable. Quite recently, however, Mr. Cayeux, conducting some researches under the auspices of the French Academy of Sciences, has discovered vestiges of certain echinoderms in the Huronian, that is to say, pre-Cambrian, deposits of the United States. It is somewhat remarkable that these organisms represent not by any means the lowest type of invertebrates, but indicate that at the time they were entombed life had already evoluted to a considerably advanced stage. Thus the actual origin of life, if we should ever be able to place it at all, must be referred back to an antiquity which baffles our imagination to properly realize. The fossils recently found in the Huronian strata will probably for a long time to come remain the oldest known to us.—*Revue Scientifique.*

Trade Notes.

A Glue for Pasting Paper on Metals.—Take two parts of granulated gum tragacanth and stir this into six parts of boiling water until dissolved. In a separate vessel make a paste of 6 parts of flour, 1 part of dextrin and 4 parts of cold water. Mix this paste with the solution and stir in 24 parts of hot water; continue stirring and add one part each of glycerin and salicylic acid.—*Bayr. Industrie u. Gewerbebl.*

Cements for Stoneware.—The following cements are especially adapted for packing joints of stoneware apparatus for chemical purposes: 1. *An elastic putty.*—Stir 3 grammes of powdered sulphur in 5½ pounds of hot linseed oil, add 1 pound of cut-up rubber waste and boil while stirring. Allow to cool, then mix with finely ground asbestos powder and stir in an iron vessel until a tough homogeneous mass is produced. 2. *A hard putty.*—This cement is made simply by dissolving asbestos in silicate of soda. Apply, and after hardening, paint over with finely ground asbestos powder and a solution of silicate of soda.

Preserving and Cleaning Antiquities.—O. A. Rhausapoulas of Athens proposes the following methods of preserving and cleaning limestone and marble antiquities: Porous limestone is repeatedly sprayed or soaked with a diluted solution (1:6) of baryta and afterward treated with a weak solution of sulphuric acid. This causes the formation of insoluble barium-sulphate in the pores of the limestone, thus giving it the desired firmness. This method has been used successfully at the National Museum of Athens. Marble statues are often found to be covered with a fatty or clayish-looking layer of extreme hardness. After considerable experimenting it was found that the cleaning of the statue could best be accomplished by using a weak solution of ammonia. The parts to be cleaned are covered with rags soaked in the ammonia. After a while it will be found that the layer begins to soften, whereupon it can easily be rubbed off.

Oxidized Steel.—Dissolve 10 grammes of sulphate of copper in twice its weight of hot water; filter and fill with water to make one quart. Dissolve 15 grammes of stannous chloride and add 20 grammes of pure hydrochloric acid. The metal which has to be free from grease is submerged in this bath and left there for 10 minutes. It is then removed, washed in water and dipped in the following solution for two or three minutes: 1.5 kilogrammes (3.3 pounds) of hyposulphite of soda is dissolved in 1 quart of water to which is added 75 grammes of pure hydrochloric acid. While the first mentioned solution can be used for a long time the second one losses its strength after two hours. It may, however, be regenerated by adding more hydrochloric acid. The solution must be filtered before adding the acid. The articles after being treated with the second bath are washed and dried. The black coating is durable and glossy.—*Electrochem. Zeitschrift.*

Cementing Rubber to Stone.—The surface of the stone where the cement is to be applied should be roughened first, which may be done with the aid of a piece of coarse emery cloth, then wiped off. The rubber, too, must be cleaned, which may best be accomplished with benzine. The following cements may be used: 1. Melt together equal parts of gutta-percha and pitch; apply hot. 2. *Marine cement.*—Dissolve 10 parts of caoutchouc in 120 parts of rectified petroleum, by allowing the mixture to stand in a warm place for several days. Then melt 20 parts of asphalt and add to the solution while stirring. Heat carefully on a waterbath (not on the open flame). If the cement is not to be used at once, but kept for future use, it has to be melted again when required. This is done by heating first on the waterbath and then *very cautiously* at an open fire to 150 deg. Cent. (300 deg. Fahr.). 3. Make a thick solution of gum sandarac and gum mastic in alcohol and add a few drops of oil of turpentine. Mix this mass with a concentrated solution of isinglass and gelatine and force the thick liquid through a flannel bag.—*Gummi Zeitung.*

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